ARMORED MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

Annual Historical Report

of

Armored Medical Research Laboratory

for 1945

(Revised 10 January 1946)

C O N T E N T S

ARMORED MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

SPMEA 319.1 10 January 1946

SUBJECT: Historical Report

TO: Army Industrial Hygiene Laboratory
Edgewood Arsenal, Maryland

1. In compliance with letter, The Surgeon General's Office, Washington, D. C., dated 18 August 1945, the following historical account is submitted:

2. INTRODUCTION:

a. The Armored Medical Research Laboratory was established at Fort Knox, Kentucky, on 1 September 1942, and the present laboratory building was occupied on that date (Appendix A, Part 1).

b. Even before the activation of the Armored Force on 10 July 1940 (Appendix A, Part 2) it was recognized that personnel operating armored vehicles are subject to physical and mental stress calling for unusual performance. Analogous stresses exist in other groups of military personnel, e.g., air crews, submarine crews, divers and others. The increasing mechanization of war is a counterpart of the general industrialization which has reached a high level of development in American life. Even in peace there was increasing mechanization so that railway engineers, truck drivers, riveters, press and machinery operators, and a host of other specialized workers, were subject to well recognized hazards. Around such workers the disciplines of Industrial Medicine had erected a science of protective measures and apparatus which included studies on work schedules, environmental conditions producing comfort or avoiding danger, and a vast number of additional aspects of the interwoven problems of man and the machine.

c. Implicit in recognition of what may be called the industrial hazards of armored personnel was the necessity of exploring the peculiar difficulties and dangers that existed in the mere operation of armored vehicles. This was necessary before a study could be made logically of the additional hazards of combat. A solution of such problems would be of benefit to other arms because of the similarity of conditions, and the basic information would be of general relevance because it is not unique to a single group.

d. Recognition of the existence of such problems led to consideration of solution. Definition of the precise scope, nature and relative importance of the problems was required before research could be directed toward their solution. No agency in the Army existed for any of these missions. Accordingly in 1941*,

* See Lt. Col. W.L. Cook's office for exact date.

the Armored Force referred the matter of need for research facilities to the Division of Preventive Medicine, Surgeon General's Office and to the National Research Council. For a period of months, little progress was made, although the matter was taken under advisement by members of the Committee on Industrial Hygiene of the National Research Council. A resume of a meeting of this Committee held in Washington, D. C. on 10 October 1941 is included in Appendix A, Part 2. It is of interest that this document predicted closely the lines of active investigation which the laboratory followed, the entire program of work projects stemming directly from it.

e. On 21 January 1942, a group representing the Committee on Industrial Hygiene of the National Research Council and the Preventive Medicine Division of The Surgeon General's Office met at Fort Knox, Kentucky with The Commanding General and The Surgeon of the Armored Force. Persons attending various conferences and activities are given in Appendix A, Part 3. This was followed by an official request from the Commanding General, Armored Force, for the establishment of a laboratory as recommended by the Committee on Medical Research (Appendix A, Part 1). Official directive for the construction of the laboratory building was published 3 February 1942 (Appendix A, Part 1).

f. Preliminary plans for the building were submitted to numerous people who had had experience in investigating problems in Industrial Hygiene and a number of modifications of the original plans were adopted. Construction was initiated on 18 April 1942, and the building was accepted and occupied on 1 September 1942. The cost of the unit with appropriate utilities, but without equipment or supplies, was $220,000.00 (Appendix A, Part 1).

g. In April 1942, The Surgeon General's Office took steps to staff the laboratory with suitable personnel which the existing Medical Corps was not able to provide. Dr. Willard Machle, of the Kettering Laboratory at Cincinnati, accepted the directorship of the laboratory, and proceeded to select specially trained men, recruited entirely from civilian sources. Most of these men were known personally to Dr. Machle. They were all engaged in teaching or research and there was some difficulty in getting the personnel released from essential positions. Since it was correctly anticipated that there would be a delay in obtaining Commissions in the Army of the United States, provisions were made for personnel to obtain Civil Service appointments. There was some delay in these appointments also. Generally speaking, the proper type of personnel was eager to join the laboratory staff because the country was at war, and was losing on all fronts. Without this impelling force, it is probable that a properly qualified staff could not have been recruited. The original staff of 10 officers, included 4 Doctors of Medicine, 4 Ph.D's (2 Physiology, 1 Physics, 1 Chemistry) and 2 Engineers (Appendix A, Part 4).

h. The Office of Scientific Research and Development sent Dr. Machle to England on 8 June 1942 to study operating problems and to consult with the staff of the Armored Fighting Vehicle Physiological Laboratory, which had been in operation for about two years (i.e. since about eight months after the outset of hostilities in Europe). The results of this trip were discussed in Dr. Machle's confidential report to O.S.R.D. entitled "Physiological and Technical Problems of Tank Warfare," written upon his return from England on 12 July 1942.

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i. During the summer, a temporary wooden building at Fort Knox was provided for the laboratory and active work was begun in June, 1942, by 8 members of the staff. Several began work while their commissions were being processed. In August and September, 1942, 4 officers and an enlisted man from the staff were sent to the Desert Training Center, Camp Young, Indio, California, to carry out studies on armored personnel under desert conditions. In many ways, this was the most important early undertaking of the laboratory because it not only provided valuable information on fatigue in tank crews, high temperature in tanks, acceptability and utility of rations, incidence of heat disability and dust exposure of men in armored vehicles, but it gave the personnel an opportunity to see the Army functioning in the field. It provided the basis for subsequent work in the laboratory with the appropriate sense of reality and urgency which did not exist before contact with the field was established. The staff found that they received complete cooperation everywhere, once the nature of their work was explained to troops in the field. The opportunity to carry out physiologic observations on tank crews during extensive maneuvers, not only provided data on water intake and loss, ration intake and the like (see laboratory report on Operations at High Temperatures - Project No. 2), but gave the officers an insight into the general types of problems confronting Army personnel which might be solved by the laboratory, but which were ordinarily accepted as inevitable by troops in the field.

j. The results of the desert expedition made possible realistic planning of the Laboratory Research Program. In the summer of 1942, the situation in North Africa did not warrant the belief that desert operations would be completed rapidly, and plans were already being made for the U. S. Army to participate in a desert campaign. Therefore, one of the high priority projects of the laboratory was a systematic study of acclimatization, water and salt needs and other problems of health in dry heat.

k. By mid-November, 1942, permanent laboratory equipment and furniture had been installed, and borrowed and improvised equipment was dispensed with. This kind of improvisation was typical in most Army installations which required special equipment in the early days of wartime expansion. Even with high priorities, there were inevitable delays in obtaining apparatus because of the staggering demands.

l. On 4 August 1942, formal request for activation of the laboratory was made by the Commanding General, Armored Force to the Commanding General, Army Ground Forces (Appendix A, Part 1, Inclosure No. 4) and activation was accomplished 1 September 1942.

2. <u>FUNCTION</u>:

a. The function of the laboratory was delineated by the Commanding General, Armored Force, on 23 September 1942 (Appendix A, Part 1, Inclosure No. 5), and it was specified that the laboratory would conduct research and experimentation on physiological problems of practical significance to the Armored Force.

b. In essence, the purpose of the laboratory was to study the soldier in relation to his duties in the Armored Force. The aim was to obtain basic data on selection and training of personnel, and the performance of equipment, from which conclusions could be drawn to enable the individual soldier to perform his duties with maximum efficiency for the longest possible time, and to determine

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the safe limits of personnel so that they could be known by commanders and tacticians. The laboratory was part of an enormous program, both civilian and military, taking a profound interest in the primary unit of the Army, namely the individual soldier. While it is true that there are innumerable studies on anthropometry, anthropology, height, weight, basal and work metabolism of normal men which have accumulated in American Medical writings for the past fifty years, these were relatively small when compared with the plethora of reports on human disease and on animal physiology. For the first time in its history, nearly the whole investigative group in American Medicine was studying the healthy man and his capacities. This effort in all probability is the beginning of a new chapter in medical and military history in which the healthy and efficient man and "how to keep him that way" is going to play a larger role than the saving of life in the ill or wounded. The maximum mental and physical capacities of soldiers were being determined and jobs and equipment were being planned around the soldier, rather than vice versa.

3. ORGANIZATION:

a. Since the meaning of the word medicine is much broadened by such a concept, this laboratory was organized with a view to combining the disciplines of many sciences in an effort to solve the problems confronting the soldier. The Armored Medical Research Laboratory was divided into seven sections (Administrative, Medicine, Physiology, Chemistry, Ventilation, Physics and Engineering), under the direction of a Medical Officer, the Commanding Officer and Director of Research Activities. Each section was headed by a highly trained and thoroughly experienced investigator whose interest in his own field has been directed toward its application to problems of human health and sustained productive capacity. Within each section specialists in the important branches of that science have been added, each with a staff of technicians, trained by him, to carry out investigative work. Since much of the work of the laboratory was of a highly specialized type, the training of personnel to assist in various technical aspects of problems was a continuing duty since there was a constant turnover, owing to various Army directives. The organization has been further supported by liaison with The Surgeon General, the National Research Council, National Defense Research Committee, the Navy, the Air Corps, and related investigative groups in Canada and England (see Appendix A, Part 5). Such contacts are essential to a well-rounded effort and when fully developed prevent much duplication of investigations by other groups.

b. The Armored Medical Research Laboratory was operated under control and supervision of the Commanding General, Army Ground Forces, Washington, D. C., from 1 September 1942 until 3 February 1944. On that date, pursuant to W.D. Circular 98, 1944, the Armored Force Medical Research Laboratory was transferred from the jurisdiction of the Army Ground Forces to that of the Army Service Forces, and was designated a Class IV Installation under the control of the Occupational Health Division, Office of The Surgeon General, Washington, D. C., which is the system operating at present.

4. MILITARY AND CIVILIAN PERSONNEL:

The wartime laboratory functioned with an allotment of 18 officers, 43 enlisted men and 15 civilians. The ranks and grades of the personnel are shown in the attached chart of the Table of Organization. After the basic staff was appointed civilian personnel were utilized where it has been difficult to obtain

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specialized assistance from military sources (Appendix A, Part 7).

5. ACCOMPLISHMENTS:

An objective evaluation of the accomplishments of the laboratory is beset with many difficulties. It is not possible to obtain information on the fate of each of the hundreds of recommendations made in official reports, but this has been attempted in detail in Appendix B. It must be remembered that many faults in apparatus and procedure were obvious and other research organizations and the experience of troops in the field frequently led to change in military doctrine and practice as well as improvisations and "field fixes" in equipment. For that reason it is not always possible to give to this laboratory credit for achievements even when it recommended the changes. In many cases, however, the exact effect of a recommendation could be traced to its ultimate fulfillment or rejection and the role of the laboratory could be defined. In a general way the laboratory forced on certain branches of the Army recognition of the fundamental importance of research in modern mechanized war and a recognition that man rather than the machine or weapon was frequently the limiting factor in combat. Only by improving his relation to equipment and external environment was it possible for him to utilize his weapons and apparatus of destruction to greatest capacity. The following section is a general discussion of the accomplishments of the laboratory in its main fields of activity, an amplification of Appendix B to which attention is invited. Citations of the laboratory and its staff are noted in Appendix A, Part 9.

6. STUDIES IN OPERATIONS AT HIGH TEMPERATURES:

To a surprisingly high degree the suggestions and recommendations from various reports were accepted and embodied into Army doctrine. Since the circular letters from the Office of The Surgeon General embodying recommendations resulting from laboratory projects were not issued until July 1943 (Appendix B, Page 2) no effect was produced on desert warfare, but desert training was made safer and performance was thereby improved. The doctrine of management of troops in hot humid zones was not as widely disseminated but was generally known to medical officers in the Pacific Theaters. Thus principles of acclimatization, of water and salt need, of tolerable limits of heat and humidity, of the effects of clothing, of the importance of general hygiene, were made known to responsible officers. Where they were deviated from, the blame should be placed less on ignorance than on the fact that the medical officer has an anamalous position in matters of command and has no means of enforcing anything in which the command does not concur. The effectiveness of medical care is circumstantial rather than inevitable in the U. S. Army.

7. COLD WEATHER OPERATIONS:

Because the laboratory's mission was not that of testing equipment, much of the work in the cold room was devoted to getting basic facts on man's response to cool and cold environments. This inevitably included clothing and its proper use. The high incidence of trench foot during the war indicated need for study of the provoking mechanisms. Close collaboration with the O.Q.M.G. and the Climatic Research Laboratory on clothing study was maintained and a

number of projects were undertaken for O.Q.M.G. While many of the recommendations made were not acted upon directly they provided a point of departure for work by other agencies. With the limited personnel available it was not possible to conduct extensive experiments on both basic physiology and the application of fundamental principles to clothing design and testing.

8. RATIONS:

Although the garrison ration was generally satisfactory throughout the war much difficulty was encountered in the employment of packaged expeditionary force rations. Part of the difficulty resulted from trying to provide too nutritious a ration by adding yeast and other concentrates so that many components having a high satiety value and poor taste were eaten little or not at all. A critique of Army ration policy and feeding practices, pointing out theoretical shortcomings and faults already detected in theaters of operation, the Canadian winter trials of 1944 and a short field test conducted by the laboratory in 1942 helped pave the way for a comprehensive field study of emergency rations which was planned, executed and reported by members of the laboratory staff in 1944. An entire infantry battalion undergoing rigorous training in an isolated area in Colorado was tested for ration likes and dislikes, consumption and waste. Among the modalities tested were physical fitness, medical and biochemical status, rifle firing scores and officer's evaluation of subjects. Recommendations for specific deletions and additions, change in basis of issue and use of fresh rations resulted in great improvement. While developing agencies have done a notable job with rations they were handicapped because early tests were not always complete enough to give sound principles for guidance. The field test had its logical fulfillment in a nutrition survey of troops in the Pacific which was notable for two things: (1) demonstrating that a small team with its own portable laboratory and equipment could operate in theaters and indeed survey troops just out of combat and (2) demonstrating that the rations had all been improved to the point where they were acceptable and nutritional state and physical fitness were excellent, even in the tropics.

9. ANTHROPOMETRIC AND PRESELECTION STUDIES:

a. It was apparent in the early days of the war that fitting the soldier into the tank had been a consideration of relatively less importance to tank designers than matters of armor, suspension, engine and weapon. The result was not only inefficient operation, but also unnecessary hazard. Occupational injury in training was not rare. By the compilation of statistically significant data on measurements of representative soldiers the laboratory defined the soldier population. The information collected was made available to Ordnance, Signal and CWS for use in design of equipment.

b. As a logical outgrowth of the definition of the soldier from physical measurements was the preselection of armored personnel on the basis of the physical, physiological and psycholigical requirements of tank crews. Studies to this end were carried out with the formulation of basic principles. In practice, preselection was not employed to any extent by Ground Forces or the Armored Force during the war, although the Air Force and Navy demonstrated its value. Since the tank is a highly complex mechanical weapon of great capacity which places unusual demands upon its crew members, unless proper selection is

made the crew member with worst eyes may be gunner and the worst coordinated may be driver, while the best potential commander may wind up as cook in an armored unit. Even if used only in the negative sense of removing obviously unfit from specialized tasks, preselection would justify its use. It demands careful long term study in the future.

10. TOXIC GAS HAZARD IN TANKS:

a. Control of gun fumes and other noxious vapors in tanks was a problem of continued interest in the research program of the laboratory. Not only were improvements in tank ventilation developed for each new vehicle, but general principles were established. Many of the deficiencies might have been corrected by changes in design rather than by improvised methods added later. Nevertheless, many of these "field fixes" enabled tanks to operate with safety where a real hazard existed. Inadequate control of gun fumes in tanks in certain combat areas resulted in definite loss of effectivness of the tank and its crew. This fact shows the importance of initial study and analysis to evaluate the physiological characteristics of a weapon as well as those dealing with mechanical or tactical considerations. A method of attacking such problems is given in Appendix A, Part 8. In association with NDRC a device giving instantaneous recording of gas levels reduced the testing problem to one of reasonable simplicity.

b. The major contribution of the laboratory consisted of the quantitative approach to a problem about which there had been much speculation and little fact. By sound principles of analysis of patterns and timing of fire from various guns in different tanks, the entire spectrum of hazard from noxious gases was described and measured. This made possible the prediction of levels of gas under other conditions. Observations in combat might have changed the patterns selected for tests but were not available till too late to be of value.

11. PROTECTION OF TANK CREWS AGAINST FIRES:

The sources of injury by fires in tanks include burning of stowed rounds after tank penetration, burning of fuel or burning from hostile flame throwers. Since the fire hazard adds to the mental distress of combat its effects are multiple. The laboratory study began with empirical study of protective creams for preventing flash burns and of fire resistant clothing. Only later was it possible by observation in active theaters to establish the usual source of fire from penetrating missiles and means of preventing or controlling it. Studies in the field established the rate of degree of temperature rise from burning ammunition. Actually little benefit accrued to the Army because of lack of facilities for indoctrination of troops in the field in use of the protective creams which were shipped overseas. A corollary on this work consisted of extensive studies of the physiological burden imposed by various types of fire resisting impregnate in clothing worn in moist and dry heat and the best method of applying it in the field.

12. VISION AND FIRE CONTROL:

a. If any prime requirement of a tank is not satisfied its effectiveness is reduced. While this was recognized in matters of mobility, armor and fire power, it is evident that designers were not wholly conversant with the strictures put on effectiveness of armor by the human factor. One of the absolute limiting

factors was the visual capacity of the gunners. To permit a tank to operate effectively in areas denied other weapons and troops requires the direction of its fire power by members of the crew who can see without exposing themselves. An example of a similar situation is use of the periscope by a submarine crew. Adequate facilities for fire control and general vision are of vital concern in tank design. The laboratory staff was able to revolutionize the primitive and inadequate instruments in use at the beginning of the war by instituting far reaching changes in consultation with Armored Board, Armored Center and Ordnance. Basic principles were enunciated for the coordinated design of all instruments rather than the development for new instruments for every vehicle or gun. The formal reports and the achievements of the specific recommendations constitute but a small fraction of the impact of the work accomplished by the staff. Direct consultation was very effective in demonstrating to entrenched persons and groups that the methods then being used to control fire power had long been outmoded and that we were far behind the Germans whose optics industry had helped establish very effective sights.

b. Problems of fire control, at first glance, seem to be far removed from the domain of a medical laboratory. Actually recognition of the focus of man, himself, in determining requirements for design and the development of systematic principles of fire control were major contributions of the laboratory. In fact there is scarcely a region of activity in modern warfare where such an approach will not yield substantial results.

c. As part of the problem of vision, the special field of Night Vision came under consideration by members of the laboratory staff. Since the value of the night operations was recurrently demonstrated during the war it was necessary to know what were the natural limits of night vision, its variability in troops and the methods whereby the soldier could learn to exploit his potential night vision to the fullest. Though the work originally confined itself to problems peculiar to the Armored Force, later expansion included the whole of Ground Forces and collaboration with agencies working on the problem for the Air Force and the Navy. A system of classification, selection and training was formulated and put into practice. The basic influence of nocturnal visual capacity on new tactics was demonstrated, emphasizing such things as the value of binoculars for seeing and use of red goggles to conserve dark adaptation within tanks.

13. GUNNERY ERRORS:

Just as up-to-date job analysis was not employed by the peacetime Army, an objective critique of weapons and the mechanics of their employment by the soldier was never made. This could be condoned when there was ample time to train gunners in the employment of illogical and antiquated methods and instruments. When training had to be accelerated it was urgent that the instrument have as few built-in mental booby traps as possible. An evaluation of fire from the moving tank with gun controlled by gyrostabilizer revealed deficiencies in design as well as a limitation of the maximum possible accuracy of moving fire inherent in the reaction time of the gunner. Another laboratory study brought to light many correctable sources of error in existing artillery procedures and poor design of instrument scales. New instruments, designed and situated by the investigators according to sound industrial principles effected a marked reduction in frequency

of errors. These studies showed that errors in gunnery as measures of the effectiveness of the weapons are capable of systematic study and quantitative measurement which permit comparison and evaluation in the cold light of objectivity. Were such a method employed by the Army rather than the doctrine of antiquity and tradition much good would result from improved design of instruments, streamlined procedures and rational training. The fact that nothing seems to have been done to implement the results of these studies reveals a barrier of ignorance, inertia and custom separating certain military practices from the useful aid which research can bring. Unless such barriers are broken down, the effectiveness of a mechanized Army with modern machines, but ancient ideas, is partially nullified; and it is by no means certain that the mass of materiel will cover up its poor quality in another war.

14. PHYSIOLOGICAL CHARACTERISTICS OF NEW TANKS:

Definition of the operational requirements of armored vehicles in terms of physiological specifications was a basic contribution of the laboratory. As new tanks were developed they were studied to see how well they fit specifications, and for necessary modification. Since the logical study of vehicles in mock-up or pilot model stage was not possible in most instances, basic changes could rarely be made and modifications were restricted by frozen design. This experience has demonstrated that in tank design all primary requirements must be considered simultaneously at the outset and provisions made for each with such compromises as are necessary at that time. Since change in one feature may disturb others in a highly integrated complex machine like the tank, corrective changes of the fixed design may unbalance the tank functionally. Since physiological considerations at least equal those of armor, or weapon, or engine, or suspension, a physiological analysis of armored vehicles should be accomplished at the earliest possible stage of design. This doctrine was accepted in principle but never fully realized in practice.

15. STUDY OF ATABRINE ADMINISTRATION

A basic investigation of relationships between quantity and time of atabrine ingestion on one hand and concentration and content of atabrine in blood plasma on the other, was carried out on a large group of soldiers at the request of The Surgeon General. Though individual variability was great, group behavior followed definite laws which allowed the prediction of mean levels where dose and time of administration were known. Not only were the practices of the Army in suppressive therapy for malaria standardized on a logical basis, but the definite and predictable relationship of mean level and group variability to dosage has wide implications in the field of chemotherapy.

16. STUDIES IN WATER PURIFICATION:

An extensive and comprehensive investigation was made on the water purification agent "Bursoline" with a limited group of test subjects for a seven week period in the laboratory hot room. During this time working personnel were subjected to tropical heat and high daily water requirements while test concentrations of Bursoline were applied to all drinking water. No toxic effects were encountered and it was recommended that Bursoline be considered safe for use as a water purification agent if justified by further field study.

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17. DUST:

The dust generated by armored vehicles operating in dry country is a great nuisance and causes some eye irritation. It has not been regarded as a major problem by combat units and, therefore, did not receive the same attention as more important problems. Studies of dust concentrations, particle size and mineralogical composition indicate that a negligible silicosis hazard exists among armored personnel. Studies on fenders and fins to reduce dust hazards were completed. An inexpensive expendable respirator was designed and adopted. Future design of tank ventilation should include means for reducing dust providing it can be accomplished at acceptable cost.

18. NOISE AND BLAST:

Audiograms of gunnery instructors revealed considerable loss in hearing after varying periods of exposure to gun blast. Audiograms repeated on the same subjects after several months without exposure to blast showed little improvement, while those who encountered gun blast repeatedly had further deterioration in hearing. Ear protectors were found to be valuable in reducing this effect, and the recommendation that those exposed frequently be provided with protectors was implemented.

19. RESEARCH IN TANK CREW FATIGUE:

The science of industrial hygiene has established principles regarding the fatigue of workers and many aspects of its relation to comfort and efficiency as affected by mechanical factors. The laboratory staff had to establish principles of the same type for each crew member in every type of tank in physiological and engineering terms. The physiological studies included measurement of energy output required for various crew activities, physical fitness and methods for its evaluation and effects of environment upon performance. Engineering studies, actually a matter of fitting the man into the tank, rather than the more logical procedure of building the tank around the structure and capacities of the man, included design of most effective seats, hatchways, ammunition stowage, positioning of controls, dials, levers, etc. and elimination of unnecessary obstructive and dangerous excresences. Measurement of work rates showed that weight, size, accessibility and delivery point of ammunition rounds must be considered in tank design. Working directly with Ordnance and seat manufacturers, laboratory recommendations could be implemented fully. Alterations in size and positioning of hatchways contributed to the peace of mind and safety of crews, always sensitive to ease of escape from tanks. Many of the improvements and modifications which resulted from the collaborative efforts with the Armored Board and Ordnance reflect influence of the laboratory. They do not always figure in formal reports, but became a major factor in tank design.

20. PROTECTION OF TANK CREWS AGAINST CHEMICAL WARFARE AGENTS:

Although chemical warfare agents were not used in the war it was necessary to have insurance against their possible employment by hostile forces. In a series of studies on the protection of tank and crew from chemical warfare agents the laboratory staff established the characteristics and limitations of (1) a complete self-protecting tank, (2) individual clean air supply to each crew

member and (3) use of the standard gas mask. Each method had peculiar advantages and limitations. Owing to the fortunate absence of chemical attack during the war no field experience is available against which to evaluate our tentative recommendations and suggestions. No final recommendations were made. The problem requires continuing study since the potential effectiveness of chemicals against tanks is very high. Positive pressure ventilation of tanks is illustrative of the multiple utility of a single method or device in improving the safety, comfort, usefulness and effectiveness of armored vehicles. By such a contrivance external chemical agents can be kept out, entrance of dust and water can be minimized and toxic gases from the guns can be rapidly removed from the crew compartment.

21. SHORTCOMINGS OF THE LABORATORY

a. In view of the really massive achievements of the laboratory, its profound impact upon so many phases of Army practice and doctrine, its role in demonstrating to the Army the essential place of research in mechanized war, criticism of its shortcomings should not have a disproportionate place in its history. This section is largely the personalopinion of the historian, but may be said to represent the consensus of the younger members of the staff. It is neither a junior officer's criticism of his superiors nor a civilian's systematic annoyance with the stereotyped procedures of the Army, but rather an effort at objective evaluation of what is necessarily a subjective topic.

b. Delay in establishment of the laboratory may be taken as an example of acceptance of the status quo characterizing both military and civilian unpreparedness for war which was epitomized at Pearl Harbor. Once the urgent need for such a laboratory was recognized there were further but necessary delays in planning the structure, procuring and commissioning of personnel, letting the contract and obtaining the necessary equipment and apparatus. An example of the early delay may be found in Appendix A, Part 6. Delays in the actual construction of the building were the result of the sudden strain of greatly expanded construction early in the war, lack of labor, materials and time.

c. In planning the laboratory two types of mistakes were made. They were mistakes which resulted from the actual course pursued by the laboratory rather than from errors in theory or in judgment. The first mistake derived from the fact that the building, experimental chambers and air conditioning apparatus were designed for the study of armored vehicles rather than from the central focus upon the man and his relationship to weapon, vehicle and environment. Thus the hot room and cold room could readily maintain great extremes of temperature but precise control at less extreme ranges of heat and cold could not be sustained. Since in actuality the chambers were used almost exclusively for observations on soldiers, many improvisations had to be instituted. Showers and latrines were not located adjacent to, or within the chambers, necessitating regular trips by subjects out of the experimental environments. No provisions for sleeping quarters had been made, and no kitchen or mess facilities were available. A number of expedients were resorted to in order to solve such difficulties so that the laboratory could function as a metabolic ward. The chambers, themselves, were poorly designed from the point of view of placing instruments

and apparatus used in physiological observations and much of the air conditioning equipment, placed within the chambers, interfered with various procedures. Because of the staff of engineers and machinists these difficulties were largely overcome and new methods and equipment were instituted from time to time.

d. A second mistake was the separation in the building of the physiological laboratories from the experimental chambers and the inadequacy of the control rooms located next to the hot and cold chambers. There was always an overflow of apparatus cluttering up halls and passage ways, an inconvenience more than an absolute hindrance to efficient work.

e. The most striking deficiency in laboratory function was lack of continual contact with troops in the field, on maneuvers and in combat. Since the staff of research workers was entirely without previous Army experience there was no backlog of information as to what were really vital problems capable of ready solution. Furthermore, it is obvious that even an exact evaluation of the situation in training and maneuvers may have little relation to problems of campaigns and combat. Furthermore, problems vary with theaters and with change in seasons. While it was true that the productivity of the staff was excellent and sustained there was a feeling of frustration on the part of staff members that though in the Army they were not of it, and it was not possible to get the precise information wanted at second-hand from a steady stream of personnel from combat who were interviewed by members of the staff at every opportunity and from the many visitors (Appendix A, Part 5). The fault of this system is that the untrained observer is an unreliable witness, and unless special pains are taken to find out exact things, information recollected later and reported at second hand is diffuse and vague and overcolored by personal factors. Thus members of the staff were not sure that the problems they were working on were those which actually mattered. Lack of laboratory personnel as observers resulted in part from resistance from higher authority and in part was the policy of the laboratory. That the output of research was generally applicable to the Army in the field was more an indication of the universal need for such work than a logically established method of studying problems known to be of practical importance. It is by no means certain that first problems were tackled first.

f. Another factor which reduced the productivity of the laboratory was the antiquated business system employed by the Army to carry on its affairs, some of the worst features of which are exemplified by the term "channels". At best handling simple transactions by a staggered series of echelons results in delay. At worst it permits a veto by anyone along the chain of a bureaucratic hierarchy. Consent must be unanimous for any project to go forward. Thus progress may be obstructed because of stupidity, jealousy, whimsey, laziness, ignorance, fear, or to protect some negligent friend. Very often a weapon, a vehicle, or doctrine represents an officer or his pet project. When this is known, junior officers are loath to criticize it or even point out obvious defects for fear that it will hurt their own career. Thus objective criticism, an absolute essential in science, is at least never encouraged by the Army system. In any military system there must be proper authority and respect for command but in questions of science right is not a prerogative of seniority and the correct approach to

solving a problem bears no very close relationship to military rank.

g. Since the Army makes no pretense of training scientists it naturally had little background for judging the methodology of investigators. When the laboratory staff trained in highly specialized fields remote from military thoughts found a profound lack of basic data on all kinds of problems, they sometimes undertook tasks far from their original field. Thus a ventilating engineer and a physiologist from the laboratory contributed to a fundamental study on "Errors in Field Artillery Practice" (Armored Medical Research Laboratory Report on Project No. 37, dated 18 September 1944). The fact that the laboratory was called upon to perform tests which revealed the urgent need for change, but was not able to follow through, indicates a weakness in its position in the fabric of the Army. If a test revealed a satisfactory situation it was accepted by the affected agency or persons, but if it pointed out obvious defects and indicated prodigious mental incapacity or an unjustifiably tradition-bound outlook, the results might not be accepted or used by the very agency requesting the test. Compare recommendations of the ration test (implemented) and the study of gunnery errors (neglected).

h. Many projects had little direct relationship to medicine or physiology but could be solved by the objective methods of a simple experiment. Thus the laboratory was called upon to operate in fields scarcely impinging upon medicine and part of its unique contribution lay in its panoramic viewpoint and its eclectic approach which encompassed many sciences. The very wideness of the area surveyed by such a small staff resulted in great emphasis on the empirical method. Since the urgency of the national and international crisis demanded immediate action rather than classical research much of the work was aimed at getting practical solutions quickly rather than accumulating basic data from which general laws could be deduced. Nevertheless, there were certain problems which required factual data before solutions could be obtained (e.g. measurements of size and shape characterizing Army personnel so the information could be used in tank design). Much speed was lost because certain problems could not be approached without fundamental data which the laboratory staff had to obtain. The lesson to be learned is that unless such facts are accumulated constantly in the more leisurely periods of peace another emergency will find the Army in exactly the same plight; and one is justified in guessing that there will be no period of grace for retooling outmoded ideas. The program of continued research should therefore include gathering data on many aspects of man.

i. One of the very serious shortcomings of the laboratory as set up was lack of a formal method of getting recommendations implemented. When a specific problem was assigned the laboratory, there was outside interest in a solution, but since the staff members were not thoroughly versed in procurement, design and production problems, there was resistance on the part of manufacturers to make radical changes. There were inevitable clashes of ideas, personalities and temperaments, many of which could have been eliminated by better mutual understanding arising from adequate liaison and provision for carrying out suggested changes in matters of both design and procedure. This contributed to the sense

of frustration sometimes felt by the staff. Had the laboratory been in on the ground floor and had access to pilot models and mock-ups of tanks much of the later difficulty could have been obviated before design was frozen and the ponderous process of procurement had become fixed.

j. Since there was no established provision for fulfilling recommendations and widely disseminating the results of research, opportunity of systematic indoctrination of student personnel of The Armored School at Fort Knox would have furnished a practical though informal method of spreading the gospel. It was never tried.

k. In a technical laboratory the supply of equipment and material is of high importance and the Army's system of handling the minutiae of property has to be studied in detail in order to avoid protracted delays by farsighted prediction of needs. Thus in the most simple transaction there may be an elaborate ritual which must be celebrated in order to comply with regulations. The entire business system of the Army could be streamlined with a great increase in its efficiency which would be manifest by increased productivity of the laboratory. Technicians trained by the laboratory staff were absolutely necessary to its proper function. Because of military necessity highly trained personnel were frequently ordered from the laboratory to other units, causing untoward delay and extra work on the directors of various research projects. Provision should be made to retain such key assistants for whom the laboratory has great need.

l. A number of somewhat trivial factors might be considered shortcomings of minor importance. The laboratory rapidly became a showplace for touring dignitaries and persons of high rank and title, with their retinue of camp followers. In the small compass of the laboratory building these routine pilgrimages distracted the staff. A single guide might have been assigned and an effort made to encourage conference with those genuinely interested, who often gave great assistance; and side track the merely curious. Among the staff there was a justifiable feeling that there was no official recognition of the job the laboratory was accomplishing. While it is hardly desirable to strike off a medal for fulfilling duty, as has been done, commendation to persons and the laboratory as a group would have improved morale. Since scientists have as one of their motivating forces recognition by others it might be well for the Army to recognize this trait. While awards have been given to the laboratory and its higher ranking officers (Appendix A, Part 9) this came as an afterthought and not as an incentive.

m. The fact that not one of the members of the laboratory staff was interested in staying in the peacetime Army or continuing to do research under the Army is silent testimony which has a self evident interpretation. Unless the Army is able to attract personnel of a high type its program of research will die in infancy. This is true whether the program is set up within the Army or carried on by civilian scientists under the auspices of the Army (i.e. Civil Service).

22. SUMMARY:

a. Beginning de novo, without facilities for research or precedent for action, the Armored Medical Research Laboratory had a staff functioning within seven months of the outset of the war, was housed in its permanent building two months later and before the year was out had completed and reported on a number of projects. Bringing together a small group of civilian scientists it was able to apply the methods of modern scientific research to the problems of the individual soldier. At first the efforts were focussed on the interrelation of the man, his weapon, the tank and the external environment. Very rapidly the scope of work broadened to encompass such problems as acclimatization to heat, physical fitness, atabrine metabolism, vision, fire control, nutrition, foot disabilities, human burns and a host of others. Thus from its origin as a highly specialized laboratory, working essentially on the study of the tank and its crew in terms of industrial hygiene, itdeveloped into a laboratory of man, studying the soldier as affected by his environments and as he operated his elaborate machines and weapons.

b. Novel approaches and methodology were justified because speed was essential. Thus problems which should have had more fundamental study were solved by empirical methods. With highly trained specialists working in close concert many new approaches in investigation came to light, and new channels of thought were employed by many members of the staff. Thus well integrated teamwork facilitated the solution of many problems in a manner unique but logical.

c. The achievements of the laboratory are highlighted by the one fact that the utility and necessity for research were made clear to the Army in terms of objective change and improvement in weapons, vehicles and above all in rules for improving the effectiveness of men using the complex machines of war. While the soldier has always had the consideration of truly good commanders, it was demonstrated as fact that the success of warfare now depended on an understanding of the relationship of the soldier, his tasks, training, equipment, environment, health and his limitations in various phases of the interplay of these broad factors Thus the tactician unaware of the hazards of trench foot not only delayed or lost battles but was morally responsible for untold and unnecessary suffering. The commander of armored units with inferior armor, guns or visual devices had an initial and profound handicap which could be overcome only by mass of materiel.

d. Failures in the laboratory program may be traced clearly to the dogma of Army methodology rather than any shortcoming in the techniques or personnel which were exploited to the fullest. The Army's conscious or subconscious resistance to change, sometimes ineffectual liaison, lack of an instrument for translating recommendations into accomplishment, the crushing minutiae of protocol for business through channels and the apotheosis of the-form-filled-out-in-quintuplicate were deterrents along the road. The achievements by the laboratory, its impact on military doctrine and design, its proper stress of the individual soldier as the keystone in war and its demonstration of the basic need for constant research and change all stand as tribute to its personnel, enlisted men and officers alike; and that results of its labors were seen in all theaters of war by the end of combat, demonstrate that the Army, when it accepts the implications, can profit by the contribution of research. Implicit in the experience of the

laboratory is the continuing requirement for research directed into fundamental lines for solution of such problems as were solved empirically during the war; and the uselessness of any research program unless specifications for implementing its discoveries and solutions are laid down in its charter.

William B. Bean

WILLIAM B. BEAN
Major, Medical Corps
Commanding

APPENDIX A

Part 1: First Annual Historical Report, Armored Medical Research Laboratory, Fort Knox, Kentucky, dated 11 February, 1943 (Note: There was no Second Annual Report. The next Official Document directly relating to history was The Historical Report of The Armored Medical Research Laboratory, dated 3 October, 1945 of which the present report is the final corrected and extended version).

Part 2: Some Medical Problems of the Armored Force and the Need of Facilities for Investigation and Research (See also Appendix A, Part 4, for Summary of Committee Findings and Opinions).

Part 3: Visit of Research Committee (Division of Medical Sciences) of the National Research Committee to Fort Knox, Kentucky, 21 January, 1942, and Minutes of Meeting.

Part 4: Staff of Armored Medical Research Laboratory.

Part 5: Partial List of Visitors and Collaborators at Laboratory During 1944 and 1945.

Part 6: Extract of Letter from Col. Kenner to Dr. Cushing.

Part 7: Principles for Guidance of Research and Development Agencies Responsible for Military Vehicles.

Part 8: Citations to Laboratory and Staff.

ARMORED FORCE MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky

319.1 February 11, 1943

Subject: First Annual Historical Report

To: The Surgeon General, War Department, Washington, D. C.
(Thru: The Commanding General, Armored Force, Fort Knox, Kentucky.)

1. In compliance with Circular Letter No. 168, The Surgeon General's Office, Washington, D. C., dated December 8, 1942, annual report of the Armored Force Medical Research Laboratory is submitted below.

2. INTRODUCTION. a. - This first report of the Armored Force Medical Research Laboratory follows establishment of the Laboratory in September, 1942, two years after creation of the Armored Force.

b. Since the beginnings of the Armored Force it has been apparent that personnel is exposed to environmental conditions of potential hazard, and that employment of armored and combat vehicles creates peculiar problems of fatigue and stress. Execution of rigorous duties calls for unusual physical and mental performance, raising questions of fitness and adaptability of personnel for the tasks. While these influences and considerations are of greatest importance in relation to the Armored Force, they are not unique to that group, and investigation of them would of necessity be of benefit to other arms.

c. The recognition of the existence of the problem led to consideration of solutions. It was apparent from the outset that the scope and precise nature of the problems needed to be defined, and that investigation and research was required. There existed no agency adequate for this purpose. Accordingly, early in 1941 the Armored Force referred the matter of need for research facilities, to the Division of Preventive Medicine, The Surgeon General's Office, and to the National Research Council. In September, 1941, a group representing the Committee on Industrial Medicine of the Committee on Medical Research, and their consultants, visited Fort Knox to study the problem in the field. A report of their findings and investigations (Inclosure #1) was presented for consideration to the Chief of the Armored Force, and to The Surgeon General. This was followed in December, 1941 by an official request from the Commanding General, Armored Force, for the establishment of a laboratory as recommended by the Committee on Medical Research. Official directive for the construction of the laboratory was published February 3, 1942. (Inclosure #2).

d. Construction was initiated April 18, 1942, and building completed and accepted on September 1, 1942. The cost of the unit, approximately $220,000.00, provided for the building without equipment or supplies. The characteristics of the building and its stages of growth are given in Inclosure #3.

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e. Beginning in April, 1942, steps were taken by The Surgeon General's Office to procure suitable personnel, and in June, 1942 the Office of Scientific Research and Development sent a member of the laboratory staff to England to enable a study of operating problems and consultations with the staff of the Armored Fighting Vehicle Physiological Laboratory which had been in operation there for about two years.

f. In the meantime, the staff of the Laboratory, which had been recruited from a number of civilian sources, had been enlarged to eight investigators. Work was actively in progress in temporary quarters at Fort Knox during the summer, 1942.

g. In August, 1942, five members of the staff were sent to the Desert Training Center, Camp Young, Indio, California, to set up temporary laboratory facilities and carry out studies in the desert. By the time the laboratory was ready for occupancy, much work had already been done and basic data collected on fatigue of tank crews, high temperatures in tanks, and dust exposure of men in armored vehicles. Of more importance, the results of the desert expedition made possible planning of the climatic research program now in progress.

h. In mid-November, 1942, permanent laboratory equipment and furniture was installed and much makeshift and borrowed equipment was dispensed with.

i. In August, 1942, formal request for activation of the laboratory was made by the Commanding General, Armored Force, and activation was accomplished September 1, 1942 (Inclosure #4).

3. FUNCTION AND ORGANIZATION. a.- The function of the laboratory was delineated by the Commanding General, Armored Force, on September 23, 1942 (Inclosure #5) and it was specified that the laboratory would conduct research and experimentation on physiological problems of practical significance to the Armored Force.

b. In essence, the purpose of this laboratory is to study the soldier in relation to his duties, as required in the Armored Force. The aim is to obtain the basic data on selection, training and equipment, from which conclusions may be drawn which will enable the individual soldier to perform his duties with maximum obtainable efficiency for the longest possible time, and to determine these limits so that they may be used to the best advantage by commanders and tacticians. The laboratory is a part of an enormous program, both civilian and military, which is taking a profound interest in the primary unit of the Army, namely, the individual soldier. Nearly the whole of the investigative group in American medicine is studying for the first time in its history, the healthy man and his capacities. This effort in all probability is the beginning of a new chapter in medical and military history, in which the healthy and efficient man and "how to keep him that way" is going to play a larger role than the saving of life in the ill or wounded men. The maximum mental and physical capacities of soldiers are being determined and their jobs and equipment are being planned around the soldier, rather than vice versa.

c. Since the meaning of the word medicine is much broadened by such an approach, this laboratory was organized with the view of combining the knowledge of many sciences in an effort to solve the problems confronting the soldier. The

Armored Force Medical Research Laboratory is divided into seven sections (Administration, Medicine, Physiology, Chemistry, Ventilation, Physics and Engineering), under the direction and supervision of a medical officer who is commanding officer and director of research activities. Each section is headed by a highly trained and thoroughly experienced investigator in that field, whose interest in his own field has been directed toward the application of that field to the problems of human health and sustained productive capacity. Within each section specialists in the important branches of that science have been added, each of which has a staff of technicians trained by him to carry out investigative work. The organization has been further supported by liaison with The Surgeon General, the National Research Council, National Defense Research Committee, the Navy, the Air Corps, and related investigative groups in Canada and England. Such contacts are essential to a well-rounded effort which does not seriously overlap investigations of other groups, and when fully developed prevents much loss of time and unnecessary duplication.

d. Within the Army, the laboratory is a special section of the Headquarters of the Armored Force, maintained and supplied by The Surgeon General, operating under the Services of Supply. Its Commanding Officer and Research Director, as well as all officer and enlisted personnel, are a part of Armored Force Headquarters. General supervision is maintained by the Armored Force Surgeon, Headquarters Armored Force, the internal organization of the laboratory is given in Inclosure #6.

4. MILITARY AND CIVILIAN PERSONNEL. The laboratory functions under an allotment of sixteen officers and forty enlisted men, of the ranks and grades shown in Inclosure #7. Of this allotment, twelve officers and thirty-eight enlisted men have been procured. Of the allotment of civilians, nine have been appointed, there being one civilian biochemist, one engineer, one instrument maker and six stenographers. It was believed from the outset and borne out by experience since, that any laboratory of this type would function most efficiently if its investigative personnel were 100% military. Owing to the difficulties in securing personnel who could meet the physical standards and who were otherwise acceptable to the Adjutant General's Office, it was necessary to employ some of the personnel on a civilian basis. It may be noted from the attached list (Inclosure #8) of authorized civilian personnel, that the arrangement duplicates in part the military organization. It is not anticipated that more than a few of these positions will be filled, other than stenographic and clerical requirements. Owing to the delays in obtaining commissions, and the necessity for instituting work and getting results quickly, it has been found most useful to have these civil service positions available. It is now possible to employ a man and have him appointed within a few days as a civil service employee so that he is at work within a week after selection and can be producing for the laboratory in the six-week or two-month period that is required for the processing of his application for a commission.

5. PROBLEMS AND THEIR SOLUTION. a. - The problems for investigation by the Armored Force Medical Research Laboratory have been set up as approved projects by authority of the Commanding General, Armored Force, Fort Knox, Kentucky (Inclosure #9). They are as follows:

(1) Cold Weather Operations
(2) High Temperatures in Tanks

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

(3) Toxic Cases in Armored Vehicles
(4) Dust Exposure in Armored Vehicles
(5) Crew Fatigue Research
(6) Vision in Tanks
(7) Night Vision from Tanks
(8) Methods of Preselection of Armored Force Personnel
(9) Anthropometric Measurements of Armored Force Personnel

b. For ease of administration within the laboratory and allocation of responsibility, a number of sub-projects have been set up. These will indicate the fashion in which the work on the major problems will be undertaken (Inclosure #10).

c. Work on some phases of all major projects is in progress at this time. Many of them are susceptible to prompt elucidation; some will take a considerable period of time; others will be in progress throughout the duration of the war emergency.

d. The following reports have been submitted:

(1) Report on Evaporative Ambulance Cooler
(2) Report on Results of Desert Field Study
(3) Detailed Report on Test of Adequacy of K-2 Ration in the Desert
(4) Partial Report on Water and Salt Requirements for Desert Operations
(5) Revised Report on Adequate Head Room in Tanks
(6) Partial Report on the Use of Red Light for Maintaining Dark Adaptation in Tanks
(7) Report on Study of the Heat Retaining Capacities of Insulated Jugs
(8) Report on Carbon Monoxide Hazards from Auxiliary Generators in Tanks
(9) Partial Report on Ventilation Requirements for Gas-Proofing the M5 Tank

e. Project reports are forwarded to:

To	No. of Copies
The Commanding General, Armored Force, Fort Knox, Kentucky.	3
The Commanding General, Army Ground Forces, Army War College, Washington, D.C.	3

To	No. of Copies
Director, Bureau Medicine & Surgery, Division of Preventive Medicine, U. S. Navy, Washington, D. C.	1
Chief, Aero Medical Research Laboratory, Experimental Engineering Section, Material Center, Wright Field, Dayton, Ohio	1
Division of Medical Science, National Research Council, 2101 Constitution Avenue, Washington, D.C.	1
Director of the Naval Medical Research Institute, National Naval Center, Bethesda, Maryland.	1
The Surgeon General, 1818 H. Street, Washington, D. C.	3
President, Armored Force Board, Fort Knox, Kentucky.	1
President, Desert Warfare Board, Camp Young, Indio, California	1
Office of The Quartermaster General, Washington, D.C.	1

When project reports pertain to automotive vehicles, one copy is forwarded to the Liaison Officer, Army Ground Forces, Union Guardian Building, Detroit, Michigan.

f. Weekly progress reports are submitted to Headquarters, Armored Force.

g. Detailed monthly progress reports are distributed to the following:

To	No. of Copies
The Commanding General, Army Ground Forces, Army War College, Washington, D. C.	10
President, The Cavalry Board, Fort Riley, Kansas.	1
President, Coast Artillery Board, Fort Monroe, Virginia.	1
President, Field Artillery Board, Fort Bragg, North Carolina.	1
President, The Infantry Board, Fort Benning, Georgia.	1
President, Tank Destroyer Board, Camp Hood, Texas.	1
President, Desert Warfare Board, Camp Young, Indio, California.	1
President, Mountain and Winter Warfare Board, Camp Hale, Colorado.	1
President, Antiaircraft Artillery Board, Camp Davis, North Carolina.	1
The Commanding General, Armored Force, Fort Knox, Kentucky.	3
President, Armored Force Board, Fort Knox, Kentucky.	3
The Surgeon General, 1818 H. Street, Washington, D.C.	1

To	No. of Copies
Director, Bureau Medicine & Surgery, Division of Preventive Medicine, U.S. Navy, Washington, D. C.	1
Chief, Aero Medical Research Laboratory, Experimental Engineering Section, Materiel Center, Wright Field, Dayton, Ohio.	1
Director of the Naval Medical Research Institute, National Naval Center, Bethesda, Maryland.	1
Division of Medical Sciences, National Research Council, 2101 Constitution Avenue, Washington, D. C.	1
Chief Signal Officer, Office of the Signal Corps, Pentagon Building, Washington, D.C.	3

6. BILLET AND MESS. The enlisted personnel of the laboratory are quartered and rationed by Headquarters Company, Armored Force.

7. MANEUVER EXPERIENCE. In addition to active liaison with field units and boards operating in extremes of climate, it is proposed to continue field observations and studies with troops in maneuver areas. In the summer of 1942, a group of five carried out studies during maneuvers at the Desert Training Center. In February, 1943, a representative of the laboratory will be engaged in similar studies at Camp Shilo, Manitoba, Canada.

8. OTHER SUBJECTS OF INTEREST. a.- In considering the work of any group whose function is to acquire knowledge and make recommendations, it is quite proper to ask what is done about the recommendations and how well the knowledge obtained is applied. By reason of the great interest and cooperation of all military and civilian agencies with which we have delt, it has been possible to achieve application of the results of study in the laboratory, not only to design of new vehicles but in modification of existing tanks and types in production.

b. Moreover, information obtained in the studies of K-2 ration while at the Desert Training Center are being considered by the Office of the Quartermaster General in the development of modifications of present rations. As a result of

the reports on water and salt requirements, the laboratory is collaborating in the production of a training film for desert troops and in the drawing-up of regulations and procedures for medical personnel. Work on ventilation and cooling of tanks is being coordinated by this laboratory, as is a large segment of the activities which are concerned with the development of visual devices in tanks.

WILLARD MACHLE,
Lieutenant Colonel, Medical Corps,
Commanding.

10 Incls.
(See Page 9)

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10 Inclosures

#1- Extract from Resume of Discussions and Opinions of the Committee on Industrial Medicine of the Office of Scientific Research and Development Meeting, Washington, D. C., October 10, 1941. (4 pages)

#2- Letter December 8, 1941, from Commanding General, Armored Force, File AG-444.5, Subject: Establishment of Research Facilities at Headquarters, Armored Force, Fort Knox, Ky., with 6 Indorsements, and copy of Resolution Adopted by Committee on Industrial Medicine, NRC, October 10, 1941.

#3- Photograph No. 9421.

#4- Letter August 4, 1942, Headquarters Armored Force, Subject: Activation of Armored Force Medical Research Laboratory, with 5 Indorsements.

#5- Letter September 23, 1942, Headquarters Armored Force, File 632/3 GNOHD, Subject: Operation of the Armored Force Medical Research Laboratory. (2 pages)

#6- Chart - Internal Organization of the Armored Force Medical Research Laboratory.

#7- List of Present Authorized Allotment of Officers and Enlisted Men.

#8- List of Present Authorized Allotment of Civilian Personnel.

#9- Authority for Projects. (11 pages)

#10- List of Projects and Sub-projects. (16 pages)

APPENDIX A
Part 1

SOME MEDICAL PROBLEMS OF THE ARMORED FORCE AND THE NEED OF FACILITIES FOR INVESTIGATION AND RESEARCH

Visited Fort Knox in Sept 1941

Resume of Discussions and Opinions of the Committee on Industrial Medicine of the Office of Science Research and Development Meeting, Washington, D.C., October 10, 1941

E X T R A C T

These were prepared by Dr. W.P. Yant OSRD - 24 Oct. 1941

* * *

Summary of Committee Findings and Opinions

It is evident to the Committee that the personnel of the Armored Force are subject to many conditions of service and factors of environment that have a serious detrimental influence on safety, well being and physical and mental efficiency. Also, owing to these environmental factors and influences of the conditions under which the Armored Force may be required to operate, and to the exacting and rigorous physical and mental performance that is required of the operating personnel under these conditions, it is evident that special physical tests are needed to determine the fitness and adaptability of personnel to the service. It is further evident that many of these influences and factors are peculiar to the operations of the Armored Force, and that they have not received the deliberate and thorough attention that their importance demands.

The Committee believes that the required physical fitness tests can be developed and the deleterious environmental factors can be eliminated, or at least mitigated to an acceptable degree of well planned investigations and researches directed to the cause, effect, prevention and control of the influencing factors, and to allied subjects.

In order to adequately meet the urgent need for investigation and research on these subjects, the Committee believes that the necessary facilities should be established promptly. The Committee also believes that these facilities and work should be centralized within the Armored Force, where there is a broad, practical understanding of the problems in their relation to the service and function of this Force, and the availability of the elements and the personnel of the Force for use in making the necessary observations and studies and for determining the practicability and effectiveness of remedial measures. The need of this close contact and the opportunity of doing much of the work in tanks operating under practical conditions, is very important.

The facilities and plan of work should provide for the immediate utilization of adaption to the problems of the Armored Force, all of the present available information, practices and procedures that are applicable. It should further provide for making new investigations and researches that are necessary to supplement or supply new information where the present is

found to be inadequate or lacking. The investigations should be conducted not only from the viewpoint of dealing with present problems in the present designs of tanks, but also for making available information and data for consideration in the course of developing new designs of equipment for the Armored Force. An important part of the work should be tests and field trial under practical conditions, of procedures and appurtenances that may be developed by the Armored Force or other services, institutions and industrial concerns for meeting problems that pertain to the selection of personnel; and for controlling deleterious factors of environment and conditions of service. While the Committee believes that facilities for general leadership in dealing with these problems of the Armored Force should be established within this Force, the Committee also believes that it will be found desirable from time to time to allocate certain phases of work that may be highly specialized to instutions where the specialized facilities and experienced personnel may be immediately available.

Research Facilities

The ultimate physical and personnel facilities that will be required for the research and investigative work to be done on problems of the Armored Force cannot be estimated with precision, owing to the absence of knowledge of the magnitude of some of the problems and the difficulties that may be encountered in solving them. It is believed, however, that insofar as can be judged at this time, the personnel and physical facilities that are discussed briefly in the succeeding part of this resume will be required for dealing promptly with the problems in sight.

Housing facilities. A. Laboratory - 6,000 sq. ft. of floor space of suitable design for laboratory use and provided with the facilities and service required for investigations and research of a medical, physiological, physical, chemical and mechanical nature.

B. Tank chamber. One gas tight room or chamber in which tanks and the tank personnel can be subjected under controlled conditions to the environmental factors to be studied. This chamber should be of size that is ample for housing the largest size tank that is either used at present or may be used in the near future.

Personnel facilities. A wide variety of training and experience will be required for competent and efficient conduct of the investigation and research on the problems that have been discussed. The types of professions and personal services, and the number of persons, will be dependent on the training and experience of the persons that will be available. In planning and building the personnel organization, attention should be given to acquiring the following services: (a) Director or Officer-in-Charge, (b) Medical personnel, preferably those with industrial experience and a research viewpoint, to make physical examinations and observations of a medical nature, (c) Physiological and psycho-physiological services for experiments and

observations in the field of physiological response and physical and mental performance, (d) Industrial hygiene and safety engineering service for contributing the present known viewpoints and information on the control of hazards and detrimental environments in industry, (e) Chemists and physicists to determine the nature, composition and magnitude of environmental factors and to contribute the viewpoint of these sciences to remedial measures, (f) Mechanical and ventilating engineering services, for dealing with these phases of the research and development work, particularly the development and testing of remedial equipment and procedures, (g) Instrument maker and machinist services to construct special apparatus and equipment that will be required and to help develop and make working models of appurtenances that are evolved in the course of the research and development work, (h) tank operators and tank maintenance services.

It is very possible that a combination of some of the services listed in the fore-going will be found in one person. For example, the industrial hygienist may have experience in ventilation work and illumination work.

The following is a general guide list to the number of persons and the professions and grade (U.S. Civil Service Classification) in which the kind of service that is required may be found; it being understood that the final number and professions included in the organization may be modified by the experience of the particular persons that are available:

1	Officer-in-Charge	
2	Medical Officers	P 4
1	Psycho-physiologist	P 4 or 5
1	Industrial Hygienist	P 4
1	Safety Engineer	P 4
1	Chemist	P 4
1	Chemist	P 1
1	Physicist	P 4
1	Physicist	P 1
1	Mechanical Engineer	P 4
1	Mechanical Engineer	P 1
1	Instrument maker	
1	Machinist helper	
2	Biochemical or hospital technicians	SP 4 or 5
5	Scientific aides	SP 4 or 5
1	Clerk	

In the interest of expediting the work and obtaining dependable results, it is suggested that, if it is possible to find them, persons of rather high grade and with a record of good experience and accomplishment be obtained. If younger, less experienced personnel are procured, it will take at least some of them several months to become oriented in the work.

ESTIMATE OF COST

Laboratory space (semipermanent construction) and Tank Chamber. If permanent construction is adopted, the estimate must be raised.	$ 165,000.00
Special, physical and chemical equipment, such as apparatus and instruments for creating, controlling, and measuring environmental factors. Some of these should be of a fixed laboratory nature, and others of a portable nature for field observations in tanks.	45,000.00
Special medical, physiological, and psycho-physiological equipment for measuring the response to environmental factors.	10,000.00
Instrument and machine shop equipment	10,000.00
Personal Services (annual basis)	70,000.00
Total	$ 300,000.00

In making this estimate, it is assumed that tanks and other regular service equipment will be available at Fort Knox without charge to the Research allotment; also, that personnel of the Armored Force will be available for observation, both in the base laboratory and during field training and maneuvers. It is also assumed that the routine chemical supplies and equipment used in medical examinations and clinical observations will be available as a general supply issue.

The Committee believes that this estimated expenditure of money is justified, not only from the present day important objective of maintaining the combat efficiency and striking force as high as possible, but also, from the viewpoint of reducing post-service claims for compensation for injury or ill health arising in or out of service in the Armored Force.

Prepared by William P. Yant for the
Committee on Industrial Medicine,
Office of Scientific Research and
Development, October 24, 1941.

A TRUE EXACT COPY:

ERWIN J. REWNER
2nd Lt., MAC
Asst. Adjutant

[illegible]

APPENDIX A
Part 1

Directive Consecutive No. T-77
Dist. Sequence No. ORD-Louisville-T-S
Job Number Fort Knox T 1-3

AG 444.5

December 8, 1941

SUBJECT: Establishment of Research Facilities at Headquarters, Armored Force, Fort Knox, Kentucky

TO : The Adjutant General,
U. S. Army,
Washington, D. C.

1. Request authorization for the establishment of an experimental laboratory at Headquarters, Armored Force, Fort Knox, Kentucky, in accordance with the resolution of the Committee on Medical Research, National Research Council (copy attached).

2. A research facility of this nature is considered essential. Its purpose will be to increase the combat efficiency of Armored Force personnel by alleviation and/or removal of operational hazards peculiar to this arm, by increasing physical efficiency and by application of certain tests designed to facilitate selection of personnel for specific functions.

/s/ JACOB L. DEVERS
JACOB L. DEVERS,
Major General, U.S. Army,
Commanding.

3 Incls:
1-ltr. SGO, 11-14-41 w/2 Incls.
2-ltr. SGO, WD, 11-26-41.
3-Resolution, Nat'l Res. Council, 10-10-41

APPENDIX A
Part 1

Incl. #2

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Directive Consec. No. T-77
Dist. Sequence No. ORD-Louisville-T 6
Job Number Ft. Knox T 1-3

Subject: Establishment of Research Facilities at Headquarters, Armored Force, Fort Knox, Kentucky

AG 322.39 Ft. Knox
(12-8-41) MO 1st Ind.

War Department, AGO, December 15, 1941 - To The Surgeon General.

For remark and recommendation.

By order of the Secretary of War:

/s/
Adjutant General

3 Incls. n/c
SGO 322.15-16 (Ft. Knox)N 2nd Ind.

War Department, S.G.O. December 16, 1941 - To: The Adjutant General.

1. This office concurs in the opinion expressed in basic communication that the immediate establishment of an experimental laboratory at Fort Knox is urgently needed.

2. It is recommended that authority be granted to establish the laboratory requested in Par. (1) basic communication.

For the Surgeon General

/s/
John A. Rogers,
Lieut. Colonel, Medical Corps
Executive Officer

3 Incls. n/c

Subject: Establishment of Research Facilities at Headquarters, Armored Force, Fort Knox, Kentucky.

AG 322.39 Ft. Knox,
(12-8-41) MO-D 3rd Ind.

War Department, AGO, December 23, 1941 - To the Surgeon General and the Chief of Engineers, IN TURN/

For Specific recommendation as to type of facilities which it is desired be constructed at Fort Knox, and estimate of cost thereof.

By order of the Secretary of War.

/s/
Adjutant General

3 Incls. n/c

APPENDIX A
Part 1

Incl. #2

Directive Consec. No. T-77
Dist. Sequence No. ORD-Louisville-T6
Job Number Ft. Knox, T 1-3

SGO 322.15-16 (Ft. Knox)N 4th Ind.

WD, SGO, Washington, D.C., January 9, 1942 - To the Chief of Engineers

1. Enclosed herewith is a photostatic copy of the ground plan for a proposed experimental laboratory for the Armored Force at Ft. Knox, Kentucky. It is believed that the necessary basic installations are indicated in this plan, and it is recommended that the following principles receive consideration.

a. A minimum of permanent partitions.

b. A maximal flexibility and availability of services, i.e., many electric, gas, water, and air outlets.

c. Special ventilation outlets so that rooms can be subdivided into enclosures and cubicles.

d. Wall perforated for temporary wiring and piping.

e. Walls and ceilings to be provided with convenient means of attachment such as wood beams and hanging bolt eyes.

f. Electric outlets to be of simplest rugged knife-wedge type (not circuit breakers) with accessible fuse provisions in the laboratory.

g. Adequate provision for special floor load - Medium Tank, 28 tons.

h. Construction - Hollow tile or cement block.

2. An allocation of three hundred thousand dollars ($3000,000) has been estimated as necessary for the development of this project, broken down as follows:

For Construction	$180,000	
For Equipment	80,000	
For Salaries for 1 yr.	40,000	(Physicist (Physiologist (Neuro-Physiologist (Chemist (Trained technicians

4 Incls.
4th Incl (Photostat of ground plans) added.

/s/ John A. Rogers
Lieut. Colonel, Medical Corps
Executive Officer

APPENDIX A
Part 1

Dir. Consecutive No. T-77
Dist. Sequence No. ORD-Louisville, T-6
Job No. Ft. Knox T 1-3
Subject: Research Facilities

CE 652 (Fort Knox) CO-T

5th Ind.

Office, C. of E. January 23, 1942 To: The Adjutant General

1. In the absence of detailed plans, the estimated construction cost of $180,000 appears adequate.

2. In view of the urgency of the required construction as developed in the basic communication and the 2nd Indorsement thereto, it is recommended that this office be authorized to proceed with the construction without delay. Authorization should be given to incur the necessary obligations with provision for reimbursement from the next supplemental estimates.

For the Chief of Engineers:

/s/ E. K. DALEY
/t/ E. K. DALEY
Major, Corps of Engineers
Chief, Ground Troop Section

4 Incls. n/c

SUBJECT: Construction of Experimental Laboratory at Headquarters Armored Force, Fort Knox, Kentucky

AG 322.39-Ft. Knox
(12-8-41) MO-D 6th Ind.

War Department, AGO, February 3, 1942 - To the Chief of Engineers.

1. It is desired that the construction of an experimental laboratory at Headquarters, Armored Force, Fort Knox, Kentucky, be initiated at once and carried to completion without delay, incurring such present obligations as are necessary for this purpose. You will include funds for this project in the next available Supplemental Estimate in a total amount not exceeding $180,000.

2. The Surgeon General has been directed to enter items for technicians' salaries and for laboratory equipment for this laboratory in the next Supplemental Estimate to be submitted.

By order of the Secretary of War:

/s/ F.H. Jacobs
Adjutant General

A TRUE COPY:
/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt., MAC

4 Incls. n/c

Incl. #2

APPENDIX A
Part 1

Dir. Consecutive No. T77
Dist. Sequence No. ORD-Louisville-T6
Job Number: Fort Knox T1-3

NATIONAL RESEARCH COUNCIL
2101 Constitution Avenue,
Washington, D.C.

Resolution Adopted by Committee on Industrial Medicine

October 10, 1941

"Whereas, the operation of the Armored Force is attended by concomitant environmental conditions and influences that affect the safety, health, and physical and mental efficiency of the personnel, such as, breathing air containing carbon monoxide from the engine exhaust gases and from powder gases, and dusts of roadways and dry terrain; impairments and impediments to vision from gunflash and inadequate illumination; noises and vibrations that are disturbing, produce fatigue and possibly serious physical impairment; extremes of temperatures and humidities that produce fatigue, and maybe unendurable under some conditions and places of service; and impairment of physical performance and injury from jarring, jolting, impact with the internal tank structure, and shock,

Whereas, the rigorous and exacting physical and mental performance that is required under adverse environmental conditions and impediments clearly indicates the need of developing and applying special physical and psychophysiological examinations for determining the fitness and adaptability of personnel for duty with elements of the Armored Force,

Whereas, these factors, influences and problems have not received the deliberate and adequate consideration that their importance demands in either the design or in the operation of the elements of the Armored Force,

Whereas, experience has shown that occupational exposures and detrimental influences of the same and allied nature can be eliminated or controlled by research and investigation into the cause, magnitude, and means for prevention and protection,

Whereas, there are no established research and investigative facilities that have the specialized equipment and the direct associations with the Armored Force that are necessary for adequately and efficiently dealing with these problems,

Whereas, most of these problems and conditions are peculiar to the Armored Force and prejudicial to the maintenance of the combat efficiency of this striking force of the Army,

Be it resolved that adequate facilities for investigation and research be made available at the Headquarters of the Armored Force, Fort Knox, Kentucky, to study and apply in a practical way to the selection of personnel, to the operation of tanks of current design and to new tanks during the course of their design, such knowledge as is now or may later be obtained concerning the factors that affect the physical efficiency, well being, and safety of the troops of the Armored Force".

A TRUE COPY - ERWIN J. REMMER, 2nd Lt., AAC., Asst. Adjutant

WAR DEPARTMENT U. S. ENGINEER OFFICE LOUISVILLE DISTRICT

Fort Knox, Kentucky. Experimental Laboratory and Utilities. Laboratory Building. View looking northeast at front of building. (Appr.2[illegible]/30905 E.S.A. 1942-1943) Contract No.W559eng-5954, Blauner Construction Co., Chicago, Ill., contractor.

File 9421 8-19-42

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

August 4, 1942

Subject: Activation of Armored Force Medical Research Laboratory

To : The Commanding General, Army Ground Forces, Army War College, Washington, D. C.

1. Request that the Armored Force Medical Research Laboratory, now in process of construction, be activated at Fort Knox, Kentucky, August 15, 1942 in accordance with Tables of Organization 17-MRL, for the purpose of conducting research and experimentation in physiological problems of practical significance to the Armored Force.

2. The Armored Force Medical Research Laboratory, as authorized by the Secretary of War, is a medical installation under the control of the Chief of the Armored Force.

3. This laboratory will be commanded by a medical officer of the Army, and the Surgeon of the Armored Force, as a Special Staff Officer, will exercise a general supervisory function.

4. All research activities or projects will be processed through the channels applying to any project concerning the Armored Force and will be correlated with the research activities of the Armored Force Board, of which the Commanding Officer of the laboratory and the Chief of Research will be members.

5. It is recommended that The Surgeon General furnish the personnel required to operate this installation by selection of particularly qualified officers of the Medical Department, and that he make available funds for technical equipment and maintenance.

6. Authority is requested to communicate directly with the several arms and services on all matters pertaining to research activities.

/s/ Jacob L. Devers
/t/ JACOB L. DEVERS
Major General, U.S.Army,
Commanding.

Incl. #4

APPENDIX A
Part 1

1st Ind.

320.2 (Armd.Force)-GNGCT/10088
(8-4-42)

HEADQUARTERS ARMY GROUND FORCES, Army War College, Washington, D. C.,
TO: Commanding General, Services & Supply, Washington, D. C.

1. It is requested that you take appropriate action to comply with the requests contained in the basic communication.

2. It is requested that communications from your office to the Chief of the Armored Force in this connection be routed through this headquarters.

For the COMMANDING GENERAL:

/s/ J.R. Dryden
/t/ J.R. DRYDEN,
Lt. Col., A.G.D.
Asst. Ground Adj. Gen.

SPOPM 320.2-ARMORED FORCE 2nd Ind.

Headquarters, Services of Supply, Washington, August 17, 1942. TO: The Surgeon General.

Your remarks and recommendations are desired prior to August 25, 1942, with reference to activation of the Armored Force Medical Research Laboratory.

By command of Lieutenant General SOMMERVELL:

LeR. Luters,
Brigadier General, G.S.C.,
Assistant Chief of Staff for
Operations, S.O.S.

/s/ A. V. Winton
/t/ A. V. WINTON
Colonel, General Staff Corps,
Executive for Operations

War Department, S.O.S., SPMCF, August 21, 1942. - To: Headquarters, Service of Supply, Operations Division.

1. Recommend activation of this unit by Army Ground Forces in accordance with Tables of Organization 17-MRL.

2. It is requested that approved projects for investigation and research which are referred to the Armored Force Medical Research Laboratory by the Armored Force Board be furnished to The Office of The Surgeon General, in order to provide a basis for request of funds needed for the equipment, personnel and maintenance of the laboratory.

3. Funds for the Armored Force Medical Research Laboratory, in the amounts indicated below, have been appropriated for the Medical and Hospital Department:

SIXTH SUPPLEMENTAL NATIONAL
DEFENSE APPROPRIATION ACT, FY 1942

Salaries	$40,000	
Laboratory equipment	80,000	
Total		$120,000

REGULAR FISCAL YEAR 1943

Salaries	$50,000		
Repairs and alterations	1,250		
Supplies	5,000		
Equipment	25,000		
Total		$81,250	
TOTAL			$201,250

Allotments, as indicated below, have been issued:

FISCAL YEAR 1942

Expenditures $10,473.71

FISCAL YEAR 1943

Allotments			
Salaries	$32,000		
Other purposes	58,000		
Total		$90,000	
TOTAL			$100,473.71

4. It appears that The Surgeon General has complied with the recommendation in paragraph 5, since the funds which have been allotted have not been expended.

APPENDIX A
Part 1

Incl. #4

5. Steps will be taken to procure the personnel as soon as this office is informed concerning the type and qualification required.

For The Surgeon General:

/s/ Larry B. McAfee,
/t/ LARRY B. McAFEE,
Brigadier General,
Assistant to The Surgeon General.

SPOPU 320.2 (8-4-42) 4th Ind.

Headquarters, Services of Supply, Washington, D.C., August 28, 1942
To: Commanding General, Army Ground Forces, (Operations Division).

1. Reference is made to added inclosure AG 444.5, December 8, 1942, subject: "Establishment of Research Facilities at Headquarters, Armored Force, Fort Knox, Kentucky", with seven indorsements, and to photostat copy tentative T/O No. 17-MRL.

2. Reference is also made to letters file No. AG 320.2 (5-31-42) June 1,1942, and AG 221 (4-17-42)EA-SP, June 6, 1942, wherein an allotment of War Department overhead of 16 officers and 23 enlisted men was made in accordance with T/O 17-MRL for the Armored Force Medical Research Laboratory.

3. Concurrence is given for direct communication by the Commanding General, Armored Forces with the Surgeon General for furnishing pertinent information in reference to the 3rd Indorsement and with the Chiefs of Several services as requested in paragraph 6 in inclosed letter of August 4, 1942.

For the Commanding General:

LeR. Lutes,
Brigadier General, G.S.C.,
Assistant Chief of Staff for
Operations,S.O.S.

Inclosures: 2 added
Ltr frm CG, Ft Knox,
12-8-41
T/O 17-MRL

/s/ A.V. Winton
/t/ A. V. WINTON
Colonel, General Staff Corps
Executive for Operations

APPENDIX A
Part 1

5th Ind.

320.2 (Armd Fc)-GNGCT/10649
(8-4-42)
HEADQUARTERS, ARMY GROUND FORCES, Army War College, Washington, D.C. To: Chief of the Armored Force, Fort Knox, Kentucky

1. Attention is directed to 3rd and 4th Indorsements.

2. The Armored Force Medical Research Laboratory will function under the War Department allotment cited in paragraph 2, 4th Indorsement. Consitution and activation of this unit is unnecessary.

3. Direct communication between all concerned is authorized.

By command of LT. GEN. MCNAIR:

/s/ L. Duenwog
/t/ L. Duenwog
Major A.G.D.
Asst. Ground Adj. Gen.

Incls.
n/c

A TRUE COPY

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

632/3 GNOHD September 23, 1942

SUBJECT: Operation of the Armored Force Medical Research Laboratory.

TO : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

1. Command.

a. The Armored Force Medical Research Laboratory will be commanded by the senior medical officer present.

b. The Laboratory will function as a medical research agency of the Armored Force. The Commander of the Laboratory is ex officio a member of the Armored Force Board, and the President of the Armored Force Board is ex officio a member of the staff of the Armored Force Medical Research Laboratory. The director of research and other personnel of the Laboratory are available to the President of the Armored Force Board in an advisory capacity, and the personnel of the Board are available in an advisory capacity to the Commander of the Laboratory.

2. Functions and Duties.

The Armored Force Medical Research Laboratory will conduct research and experimentation in physiological problems of practical significance to the Armored Force. All research activities or projects will be processed through the channels which apply to any project concerning the Armored Force. Armored Force Board projects and Laboratory research, where applicable, will run concurrently.

3. Projects.

a. The Armored Force Medical Research Laboratory will undertake only those projects referred to it by this headquarters.

b. The Commanding Officer, Armored Force Medical Research Laboratory, will recommend to this headquarters any projects which he deems worthy of investigation.

4. Relationship to Other Agencies.

a. The Armored Force Surgeon, as a special staff officer of the Chief of the Armored Force, will exercise general supervision of the Laboratory, and will review all reports.

Incl. 5

APPENDIX A
Part 1

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

b. All communications of the Laboratory affecting the policies of the Armored Force will be routed through channels.

c. The Laboratory will recommend at any time the details of scientific personnel for the investigation of problems in the field and for liaison with other agencies.

5. Reports.

Reports will be submitted to this headquarters at the earliest practicable date after the completion of projects.

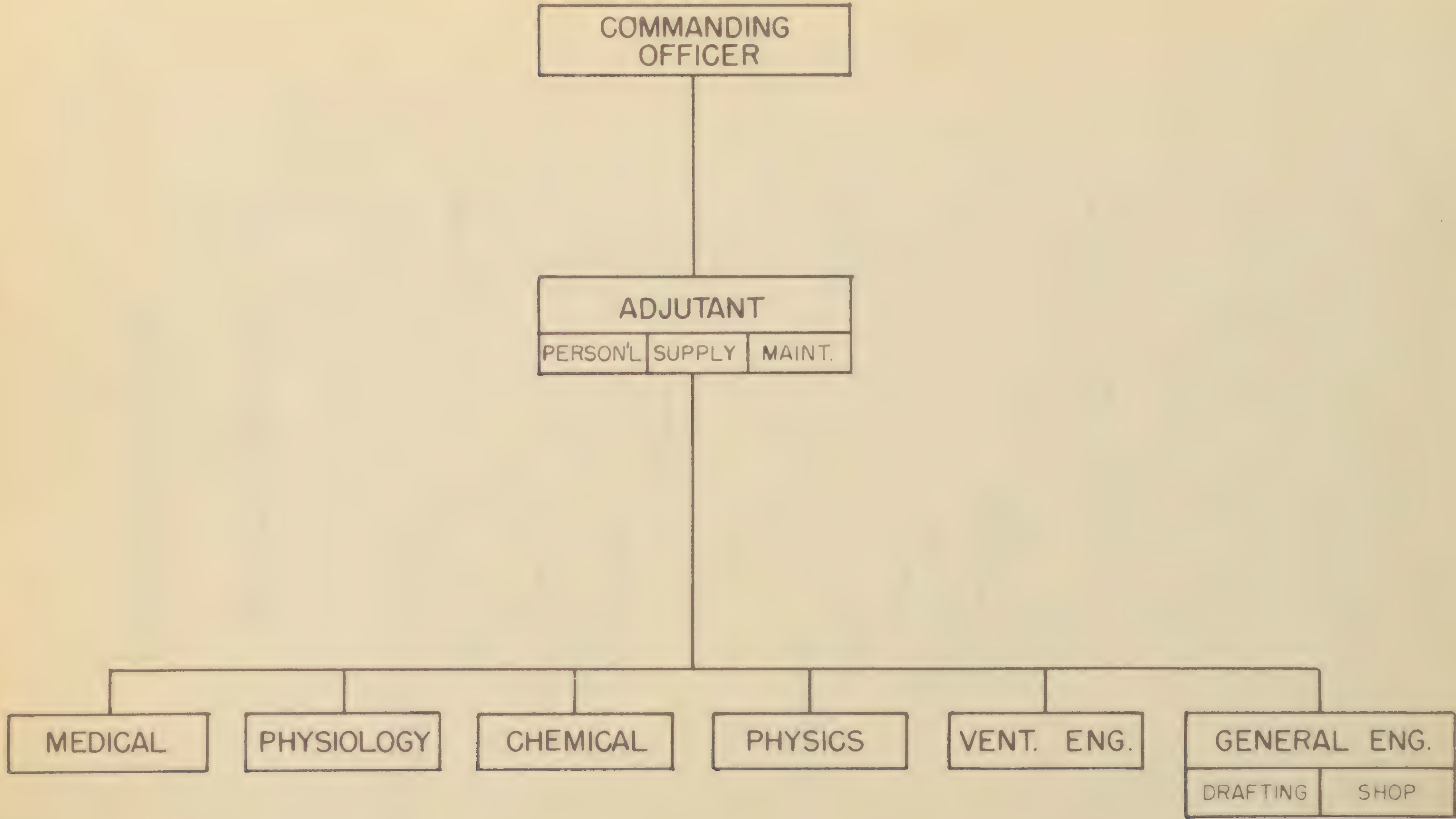
By command of Lieutenant General DEVERS:

/s/ C. M. Wells
/t/ C. M. WELLS,
Lieut. Colonel, A.G.D.,
Assistant Adjutant General

A TRUE COPY

s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt. MAC
Asst. Adjutant

Incl. #5


COMMANDING OFFICER
ADJUTANT
PERSON'L
SUPPLY
MAINT.
MEDICAL
PHYSIOLOGY
CHEMICAL
PHYSICS
VENT. ENG.
GENERAL ENG.
DRAFTING
SHOP

PRESENT AUTHORIZED ALLOTMENT

Of

OFFICERS AND ENLISTED MEN

1. OFFICERS

Grade	Authorized
Colonel	1
Lt. Colonel	1
Major	3
Captain	5
1st Lieutenant	6
Total Officers	16

2. ENLISTED MEN

Grade	Authorized
Mr. Sergeant	3
Tech. Sergeant	1
Sergeant	2
Tech. 3rd Grade	20
Tech. 5th Grade	4
Private, 1st Cl.	7
Private	3
Total Enl. Men	40

PRESENT AUTHORIZED ALLOTMENT
Of
CIVILIAN PERSONNEL

NUMBER	POSITION	GRADE
1	Principal Research Engineer (Chief of Research - in dual position as Chief Physiologist)	(P-5)
1	Physicist	(P-4)
1	Associate Physicist	(P-3)
3	Assistant Physicist	(P-2)
1	Internist	(P-4)
1	Associate Internist, EENT Specialist	(P-3)
2	Associated Physiologist	(P-3)
1	Assistant Physiologist	(P-2)
1	Analytical Chemist	(P-4)
1	Bio-Chemist	(P-4)
1	Research Engineer	(P-4)
1	Junior Engineer	(P-1)
1	Instrument Maker	(CU-7)
1	Instrument Maker	(CU-8)
1	Electrician	(CU-6)
1	Carpenter	(CU-6)
2	Assistant Clerk Stenographer	(CAF-3)
3	Junior Stenographer	(CAF-2)
3	Janitors	(CU-3)
3	Firemen	(CU-3)
5	Medical Technicians	(SP-5)
2	Chemical Laboratory Technicians	(SP-5)
3	Physical Laboratory Technicians	(SP-5)

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

September 24, 1942

400.112/6 GNOHD

SUBJECT: Cold Weather Operations.

To : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

1. The Armored Force Medical Research Laboratory will initiate the project subject, " Cold Weather Operations".

2. It will be necessary that this headquarters be furnished nine (9) copies of completed project.

By command of Lieutenant General DEVERS:

/s/ C. M. Wells,
/t/ C. M. WELLS,
Lieut.Colonel, A.G. D.,
Assistant Adjutant General

A TRUE COPY:

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

Incl. #9

APPENDIX A
Part 1

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

September 24, 1942

400.112/6 GNOHD

SUBJECT: High Temperature in Tanks.

TO : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

1. Authority is granted to initiate the project subject, " High Temperature in Tanks", as requested by informal memorandum of file number 724x741.

2. It will be necessary that this headquarters be furnished nine copies of completed project.

By command of Lieutenant General DEVERS:

/s/ C.M. Wells
/t/ C.M. WELLS
Lieut. Colonel, A.G.D.,
Assistant Adjutant General

A TRUE COPY:

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd. Lt., MAC
Asst. Adjutant

Incl. #9

APPENDIX A
Part 1

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

September 24, 1942

400.112/6 GNOHD

SUBJECT: Toxic Cases in Armored Vehicles.

TO : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky

1. Authority is granted to initiate the project subject, "Toxic Cases in Armored Vehicles", as requested by informal memorandum of file number 724x741.

2. It will be necessary that this headquarters be furnished nine copies of complete projects.

By command of Lieutenant General DEVERS:

/s/ C. M. Wells
/t/ C. M. WELLS,
Lieut. Colonel, A.G.D.,
Assistant Adjutant General

A TRUE COPY:

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

Incl: #9

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

September 24, 1942

400.112/6 GNOHD

SUBJECT: Dust Exposure in Armored Vehicles.

TO : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

1. Authority is granted to initiate the project subject, "Dust Exposure in Armored Vehicles", as requested by informal memorandum of file number 724x741.

2. It will be necessary that this headquarters be furnished nine copies of completed project.

By command of Lieutenant General DEVERS:

/s/ C.M. Wells
/t/ C.M. WELLS
Lieut. Colonel, A. G. D.
Assistant Adjutant General

A TRUE COPY:

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

Incl. #9

APPENDIX A
Part 1

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

September 24, 1942

400.112/6 GNOHD

SUBJECT: Crew Fatigue Research.

TO : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

1. The Armored Force Medical Research Laboratory will initiate the project subject, "Crew Fatigue Research".

2. It will be necessary that this headquarters be furnished nine (9) copies of completed project.

By command of Lieutenant General DEVERS:

/s/ C. M. Wells
/t/ C. M. WELLS,
Lieut. Colonel, A.G.D.
Assistant Adjutant General

A TRUE COPY:

/s/ Erwin J.Rewwer
ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

Incl. #9

APPENDIX A
Part 1

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

September 24, 1942

400.112/6 GNOHD

SUBJECT: Vision in Tanks.

TO : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

1. Authority is granted to initiate the project subject, "Vision in Tanks", as requested by informal memorandum of file number 724x741.

2. It will be necessary that this headquarters be furnished nine copies of completed project.

By command of Lieutenant General DEVERS:

/s/ C. M. Wells
/t/ C. M. WELLS,
Lieut.Colonel, A. G. D.,
Assistant Adjutant General

A TRUE COPY:

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

Incl. #9

HEADQUARTERS ARMORED FORCE
Office of the Commanding General
Fort Knox, Kentucky

September 24, 1942

400.112/6 GNOHD

SUBJECT: Night Vision from Tanks.

TO : Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

1. Authority is granted to initiate the project subject, "Night Vision from Tanks", as requested by informal memorandum of file number 72x741.

2. It will be necessary that this headquarters be furnished nine copies of complete project.

By command of Lieutenant General DEVERS:

/s/ C. M. Wells
/t/ C. M. WELLS,
Lieut. Colonel, A.G. D.,
Assistant Adjutant General

A TRUE COPY:

ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

Incl. #9

APPENDIX A
Part 1

ARMORED FORCE MEDICAL RESEARCH LABORATORY
Office of the Commanding Officer
Fort Knox, Kentucky

400.112-6 November 10, 1942

SUBJECT: Approval of Project "Development and Application of Preselection Tests to Armored Force Personnel".

TO : The Commanding General, Armored Force, Fort Knox, Kentucky.

1. Reference is made to attached memorandum and to inclosure, AG444.5, December 8, 1941, Subject: Establishment of Research Facilities at Headquarters, Armored Force, Fort Knox, Kentucky.

2. Request is made for approval of project "Development and Application of Preselection Tests to Armored Force Personnel".

/s/ Willard Machle
/t/ WILLARD MACHLE
Lieut. Colonel, M.C.
Commanding

2 Incls:
1-Memorandum
2-Ltr. AG 444.5
8/8/41

A TRUE COPY:

/s/ Erwin J.Rewwer
ERWIN J. REWWER
2nd. Lt., MAC
Asst. Adjutant

APPENDIX A
Part 1

Incl. #2

400.112/6 (11/10/42) GNOHD   1st Ind.

HEADQUARTERS ARMORED FORCE, Fort Knox, Kentucky, November 26, 1942.
To: Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

Approved.

By command of Lieutenant General DEVERS:

/s/ C. M. Wells
/t/ C. M. WELLS
Lieut. Colonel, A.G.D.,
Assistant Adjutant General

2 Incls: n/c

A TRUE COPY

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd. Lt., MAC
Asst. Adjutant

ARMORED FORCE MEDICAL RESEARCH LABORATORY
Office of the Commanding Officer
Fort Knox, Kentucky

400.112-6 November 25, 1942

SUBJECT: Request for Approval of Project "Anthropometric Data on Armored Force Personnel".

TO : Commanding General, Armored Force, Fort Knox, Kentucky.

1. Preliminary studies of the sitting height of men, Project Number 5-1, reported, indicates the need for data on bodily dimensions of Armored Force personnel.

2. Information of this type will be useful to designers of combat vehicles, clothing and equipage.

3. A careful study on a large series of men has already been carried out by the Army Air Force and our own data on sitting heights checks very closely with theirs. It is proposed to carry out sufficient related measurements on a large enough sample of men to establish other chatacteristics of Armored Force personnel. If, as is likely, these measurements are practically identical with those of Air Force personnel, the combined data can then be used and will be of considerable value to the manufacturing and supply services in determining the size and design of controls, vehicles and the standardization of sizes of clothing and equipment.

4. Request approval of the above project.

/s/ Willard Machle
/t/ WILLARD MACHLE
Lieut.Colonel, M. C.
Commanding

A TRUE COPY:

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd Lt., MAC
Asst. Adjutant

APPENDIX A
Part 1

Incl. #9

400.112/7 (11-25-42) GNOHD 1st Ind.

HEADQUARTERS ARMORED FORCE, Fort Knox, Kentucky, December 3, 1942
TO: Commanding Officer, Armored Force Medical Research Laboratory, Fort Knox, Kentucky.

Approved.

By command of Lieutenant General DEVERS:

/s/ C. M. Wells
/t/ C. M. WELLS,
Lieut. Colonel, A. G. D.,
Assistant Adjutant General.

A TRUE COPY

/s/ Erwin J. Rewwer
ERWIN J. REWWER
2nd. Lt., MAC
Asst. Adjutant

ARMORED FORCE MEDICAL RESEARCH LABORATORY
Office of the Commanding Officer
Fort Knox, Kentucky

400.112-6 AFMRL October 17, 1942

Subject: Sub-Projects of the Armored Force Medical Research Laboratory.

To: Commanding General, Armored Force, Fort Knox, Kentucky.

A series of projects approved for investigation by the Armored Force Medical Research Laboratory has been received. The titles have broad coverage and are entirely satisfactory as a working basis and for laying out the program of the laboratory.

In order to set up and visualize the specific investigations and to orient and plan the work of the laboratory for the next year or so, groups of sub-projects were set up under the principal project headings, it being intended that these serve as an outline of procedure. The order in which they are set up implies no priority in attack; that will of necessity be determined by the rate at which supplies and equipment come to hand. Neither can one anticipate at the moment when any single sub-project will be concluded. They will, however, be approached as rapidly as feasible and worked on as intensively as is consistent with thorough and critical investigation.

Sub-project numbers were assigned for the purpose of record keeping within the laboratory, as was the breakdown of the projects, since responsibility for certain phases of the work requires specific allocation.

Since this list will convey a very good notion of the direction which the work of the laboratory will take, it is being transmitted through channels to headquarters in order that they may be informed fully concerning our activities.

In taking up these sub-projects, the general idea will be (1) to ascertain where we stand in respect to the subject under consideration, (2) to determine the nature of the problem, and (3) to see what can be done about it. Developmental engineering or modification of design will be carried out only to the degree that is necessary to establish what needs be done. That is to say, we do not anticipate fabricating or manufacturing devices in finished form, but it may be necessary under certain circumstances to try certain materials, combinations of materials, or alterations in design to establish whether or not the procedures recommended are of practical

[illegible]

[illegible]

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[illegible]

accomplishment.

For information, a complete list of the sub-projects is appended, and a few notations are given below by way of explanation of the titles.

1. <u>PROJECT 1 - COLD WEATHER OPERATIONS.</u>

<u>a</u>. Sub-Projects 1-1 to 1-6. - The general idea behind this group is to determine whether or not the present issues are adequate for varying ranges of sub-zero temperatures, and, if not adequate for the minima likely to be encountered in arctic operations, determination of the levels at which they may be safely used. They are sub-divided as indicated, since different groups of supplies may be concerned with the different sets of articles; moreover, for convenience the data is more easily handled in that fashion.

<u>b</u>. <u>Sub-Project 1-7</u>. - Cold Weather Dietary Requirements. The present rations will be tested to determine their suitability at various levels of cold.

<u>c</u>. <u>Sub-Projects 1-8 and 1-9</u>. - In order to have contact with the practical problem and to relate the activities of the laboratory to field operations, investigating groups and/or liaison with the various boards and committees that study operations in different climates is necessary.

<u>d</u>. <u>Sub-Project 1-10</u>. - This report will boil down all the data obtained into a statement as to where the Armored Force stands in respect to cold weather operations at the time of writing.

<u>e</u>. <u>Sub-Projects 1-11, 1-12, 1-13, 1-15, 1-16, 1-17 and 1-19</u>. - In order to make the studies of this laboratory of value to other units of the ground force, sufficient basic physiologic and medical information will be obtained to enable application of the results by The Surgeon General to units other than the Armored Force.

<u>f</u>. <u>Sub-Projects 1-14 and 1-18</u>. - A study of both of these subjects is indicated if the best men are to be selected for the particular job and if the maximum efficiency of combat units is to be maintained.

2. <u>PROJECT 2 - HIGH TEMPERATURES IN TANKS</u>. The approach here is in general the same as in the case of Project 1, with the recognition of the fact that climatic conditions in the desert are markedly different than those in the jungle. Sub-projects peculiar to high temperatures are discussed below.

<u>a</u>. <u>Sub-Projects 2-6 and 2-7</u>.- Considerable confusion of thought exists concerning the water and salt needs of Armored Force personnel during

operations at high temperatures. It is proposed to establish what the minimum requirements are for maintenance of health and efficiency in order that provisions for supply can be made.

b. Sub-Project 2-18. - Impregnated and gas-proof clothing can be worn for only brief periods at high temperatures. The length of time during which it may be worn safely at various temperatures and the care that must be exercised at these times should be known.

c. Sub-Projects 2-22 to 2-27.- There has been much speculation on the cooling and air conditioning of tanks, and abortive attempts have been made to improve conditions within tanks. What is necessary at the outset is sufficient basic data to establish, (1) the magnitude and seriousness of the problem, and (2) in view of the above, whether it is even worthwhile or necessary to attempt any modification in tanks with the idea of cooling. Until this basic data has been accumulated and analyzed, the whole problem of relief of high temperatures in tanks is largely a conjectural one.

3. PROJECT 3 - TOXIC GASES IN ARMORED VEHICLES. The approach to this project is designed to establish the nature and magnitude of the problem and to develop a means of dealing with it. We already know that the concentration of ammonia fumes is sufficiently high to be undersirable for tactical reasons alone, since it interferes with accurate gunnery, in addition with firing of certain types of ammunition, dangerous quantities of carbon monoxide are found in the turrets of the M-4 series of tanks. We need now to define more precisely the seriousness of the hazard and to institute corrective measures. In order to improve conditions, it is necessary to know the characteristics of the ventilation in existing tanks. This will enable us to decide whether added ventilation is needed or whether the present volume of ventilation is not already adequate if effectively employed. It is anticipated that these sub-projects will not be reported separately but will be assembled as two or more reports covering a single current design of tank each.

a. Sub-Project 3-9. If tanks are ever successfully gas-proofed, it will be because one has succeeded in arbitrating several conflicting requirements. We propose to establish what the magnitude of each of these requirements is in order that the problem can be intelligently approached. For example, one can today gas-proof a tank completely by the simple expedient of sealing it hermetically, but unfortunately people could not live in it. It becomes necessary, therefore, to ascertain how much ventilation is needed as a minimum for the man, what is needed for proper cooling, and what is needed for removal of gun fumes; we then will examine these requirements in the light of what is practically feasible by way of purifying canisters and

dust filters. Since whatever is done to any one of these independent variables will alter one's position in respect to the other, we propose starting with what seems to be to us the most urgent and necessary from the tactical point of view, namely, the removal of gun fumes. The whole question of gas-proofing can be reviewed when this data is at hand.

4. PROJECT 4 - DUST EXPOSURE IN ARMORED VEHICLES.

a. Sub-Projects 4-1, 4-2, 4-4, 4-5 and 4-6.- Excessive amounts of dust are undesirable for tactical reasons and may be dangerous from a hygienic point of view. In studying this problem we shall first of all determine just how much dust enters the fighting compartment and then set about finding means of reducing it. A fairly large amount of data on the nature and kind of dust will be necessary for two reasons, (1) this information is required for the design of filters or respirators, and (2) since the question has been raised as to whether or not silicosis (a disabling disease) can occur as a result of tank operations, and it is necessary from a long range point of view to have at hand the data which will serve to establish the exact magnitude of the hazard. If a hazard does exist protective measures are essential; if it does not exist, it will be well to know that and to be able to support one's position when the pension and disability raids begin after the war.

b. Sub-Project 4-3.- Present respirators issued to Armored Force personnel are heavy, fairly expensive, and require maintenance. We believe that a simple type that is cheap and which can be thrown away after use should be developed.

5. PROJECT 5 - CREW FATIGUE RESEARCH. The list of sub-projects is a better indication of what we are thinking about than a group of separate and distinct investigations. All of these headings will require investigation, some can be studied simultaneously, to others the answer will be gotten from study of related projects, while some represent fairly long range investigations.

6. PROJECT 6 - VISION IN TANKS. The idea behind investigation of this project is to find out first of all where we stand, and secondly, how can we improve our position. To develop all of the ideas covered in the subprojects will require a large staff and years of investigation. On the other hand, from observations that have already been made, it is apparent that much can be done to improve the visual devices that we now have available. We do not propose constructing finished optical instruments or grinding lenses, but can, when equipment now ordered is at hand, construct working models embodying

our ideas. These can then be fitted into present tanks and subjected to practical firing tests. If this method of study and approach does nothing more, it will at least enable the Armored Force to write its own specifications for the equipment it wants to use on the basis of practical field experience with the instrument in question. Again, if the Armored Force is offered a new device or visual tool, it should be in the position of judging the equipment not only from a practical point of view, but also from a point of view of what it is possible to obtain.

7. PROJECT 7 - NIGHT VISION FROM TANKS. The tactical advantage of being able to see well enough to fight at night is considerable. There are about eight (8) moonlight nights of every month in which tanks can be operated successfully, if the proper equipment and personnel are available. Moreover, if our personnel can see better than the enemy when it is dark, it can not only see when he can not, but can see better under conditions of dim light when he is already suffering impairment. Investigation of this project will include study of methods of selection and training of personnel for night vision and suggestions for improvement of lighting in tanks, with the idea of preserving the maximum of dark adaptation.

If the Armored Force Medical Research Laboratory is to discharge its responsibility of service to the Armored Force, it can do this most effectively if it is not committed to any rigid pattern of activity. By its very nature research and investigation requires latitude of thought and this is particularly true in the investigation of practical problems. In submitting this list of sub-projects it is my feeling that we should look upon them as guides to our experimental approach and not petrify them into project headings that must be investigated, whether or not there is any good practical reason for continuing to work on them. It is almost certain that in the course of the investigation of any one of these avenues, new ideas will emerge that will not be included in the original concept. It would be better, accordingly, to permit the original group of 7 projects to stand with the understanding that the laboratory keep Headquarters advised of any noteworthy deviation from the approach covered in the outline.

Investigation of these projects will employ to its fullest use the present personnel of the laboratory, together with that requested in our recent application for increased allotment. How fast we can get answers to the problems will depend upon a number of considerations.

A point worth mentioning at this time since it has a bearing upon both personnel and equipment is a recent request from General Brewer of the 12th Division. It is his wish that we make an effort to select certain

categories of specialized personnel in the 12th Division as it is put together. Since this division will be assembled at the rate of approximately 1,000 men per day, despite the fact that most of the assisting personnel will be supplied by medical units of the 12th Division, the mere business of setting up the machinery for carrying out the work, fabricating instruments and equipment, and setting up and verifying the schedules, record forms and the like, will occupy a considerable portion of the time of this laboratory for the next six (6) weeks. In this time, the authorized projects will not be allowed to languish, but work on them can not be pushed as vigorously as would otherwise be the case.

/s/ Willard Lachle
/t/ WILLARD MACHLE
Lt. Col., Medical Corps
Commanding.

COLD WEATHER OPERATIONS

PROJECT NO. 1

Sub-Project	Title
1-1	Test of the Adequacy and Ranges of Use of Winter Combat Clothing.
1-2	Test of the Adequacy and Ranges of Use of Winter Sleeping Issues.
1-3	Test of the Adequacy and Ranges of Use of Winter Shelters.
1-4	Test of the Adequacy and Ranges of Use of Winter Gloves and Hand Warmers.
1-5	Test of the Adequacy and Ranges of Use of Winter Face and Head Protectors.
1-6	Test of the Adequacy and Ranges of Use of Winter Foot Coverings.
1-7	Test of Adequacy of all Combat Zone Rations Intended for Use in Sub-zero Climates.
1-8	Report on Results of Field Study and Liaison with Winter Operations Groups.
1-9	Report on Results of Field Study and Liaison with Mountain Board.
1-10	Analysis of Position of Armored Force Personnel in Respect to Winter Protection with Recommendations for Use and/or Design of suitable Equipment and Food.
1-11	Influence of Cold Upon Efficiency of Personnel.
1-12	Study of the Effects of Wetting Upon the Efficiency of Winter Clothing.
1-13	Study of Properties of Winter Clothing. a. Permeability to Air. b. Transparency to Radiation. c. Relation of Weight to Warmth. d. Relation of Bulk to Weight and Warmth.
1-14	Study of Methods of Attaining and Maintaining Acclimatization to Cold.
1-15	Study of the Total and Specific Dietary Requirements for Cold Weather.

Incl. #10

COLD WEATHER OPERATIONS

PROJECT NO. 1

(Cont'd.)

Sub-Project	Title
1-16	Study of Methods for Proper First Aid Care of Incipient and Fully Developed Frost Bite.
1-17	Test of Effects of Various Stimulants.
1-18	Study of Methods of Selection of Men for Cold Weather Operations.
1-19	Study of the Physiologic Effects of Cold.
1-20	Study of the Heat-Retaining Capacity of Insulated Jugs.

OPERATIONS AT HIGH TEMPERATURES
HIGH TEMPERATURES IN TANKS

PROJECT NO. 2

Sub-Project	Title
2-1	Test of the Adequacy and Ranges of Use of Clothing for Desert Operations.
2-2	Determination of the Clothing and Sleeping Equipment Best Suited for Desert Operations.
2-3	Test of the Adequacy and Ranges of Use of Clothing for Jungle Operations.
2-4	Determination of the Clothing and Sleeping Equipment Best Suited for Jungle Operations.
2-5	Test of Adequacy of all Combat Zone Rations Intended for Use in Operations at High Temperatures.
2-6	Determination of Water and Salt Requirements for Desert Operations.
2-7	Determination of Water and Salt Requirements for Jungle Operations.
2-8	Report on Results of Field Study and Liaison with Desert Warfare Board.

Incl. #10

OPERATIONS AT HIGH TEMPERATURES
HIGH TEMPERATURES IN TANKS

PROJECT NO. 2

(Cont'd.)

Sub-Project	Title
2-9	Report on Results of Field Study and Liaison with Tropical Board.
2-10	Analysis of Position of Armored Force Personnel in Respect to Operations at High Temperatures with Recommendation for Use and/or Design of Suitable Equipment and Food.
2-11	Influence of High Temperatures Upon the Efficiency of Personnel.
2-12	Study of Methods of Attaining and Maintaining Acclimatization to High Temperatures.
2-13	Effect of Training Upon the Efficiency of Performance at High Temperatures.
2-14	Study of the Total and Specific Dietary Requirements for Operations at High Temperatures.
2-15	Study of the Effects of Drugs and Accessory Food Factors on Efficiency of Personnel at High Temperatures.
2-16	Study of Methods of Selection of Men for Operations at High Temperatures.
2-17	Study of the Physiologic Effects of High Temperatures.
2-18	Effects of Impregnated and Impervious Clothing Upon Efficiency of Personnel at High Temperatures.
2-19	Study of Efficiency of Performance and Rate of Deterioration Under Conditions of Water Limitation.
2-20	Study of Methods of Ventilating Suits Proved Impractical for Continuous Wear.
2-21	Study of Properties of Clothing for Hot Weather Operations.
2-22	Determination of the Amount of Heat Transmitted to the Fighting Compartment of Tanks under Field Conditions.
2-23	Determination of the Amount of Heat Transmitted to the Fighting Compartment of Tanks by the Transmission and Final Drive.

OPERATIONS AT HIGH TEMPERATURES
HIGH TEMPERATURES IN TANKS

PROJECT NO. 2
(Cont'd.)

Sub-Project	Title
2-24	Study of Methods of Reducing the Heat Load in Tanks.
2-25	Determination of the Optimum Amount and Distribution of Ventilation Within the Fighting Compartment.
2-26	Evaluation of the Practical Value of Evaporative Cooling as a Means of Improving Comfort in Tanks.
2-27	Determination of the Refrigeration Load in Tanks and the Size, Weight and Power Requirements of Refrigeration Systems.

TOXIC GASES IN ARMORED VEHICLES

PROJECT NO.3

Sub-Project	Title
3-1	Determination of the Characteristics and Effects Upon the Crew of Gun Fumes from Firing of the Weapons in Tanks of the M-4 Series.
3-2	Determination of the Characteristics and Effects Upon the Crew of Gun Fumes from Firing of the Weapons in Tanks of the M-5 Series.
3-3	Determination of the Characteristics and Effects Upon the Crew of Gases Arising from the Operation of Engines in Armored Vehicles.
3-4	Determination of the Basic Ventilation Characteristics of Tanks of the M-4 Series
3-5	Correlation of Basic Ventilation Data with Gun Fume Studies and Developing of an Effective Design of Improved Ventilation for the Control of Gun Fumes in M-4 Tanks.
3-6	Determination of the Basic Ventilation Characteristics of Tanks of the M-5 Series.

TOXIC GASES IN ARMORED VEHICLES

PROJECT NO. 3

(Cont'd.)

Sub-Project	Title
3-7	Correlation of Basic Ventilation Data with Gun Fume Studies and Development of an Effective Design of Improved Ventilation for the Control of Gun Fumes in M-5 Tanks.
3-8	Measurement of the Quantity of Toxic Gases Entering the Crew Compartment of Tanks Following Discharge of a Single Round of Various Types of Ammunition.
3-9	Determination of Ventilation Requirements for Gas-proofing Tanks.
3-10	Study of the Amount and Composition of Vapors Released into Tanks from the Transmission and Final Drive.
3-11	Determination of the Ease and Speed of Donning Protective Clothing.

DUST EXPOSURE IN ARMORED VEHICLES

PROJECT NO. 4

Sub-Project	Title
4-1	Determination of Dust-Loads and Characteristics of Dusts Encountered in the Operation of Armored Vehicles.
4-2	Investigation of the Value of Deflectors in Reducing the Amount of Dust Exposure in Armored Vehicles.
4-3	Development of a Simple Type of Throw-Away Dust Respirator.
4-4	Determination of the Design Requirements of Air Cleaners for the Control of Dust in Tanks.
4-5	Testing of Commercial Types of Air Cleaners for Control of Dust in Tanks.
4-6	Determination of Practical Standards of Permissible Dustiness for Tank Fighting Compartments.

CREW FATIGUE RESEARCH

PROJECT NO. 5

Sub-Project	Title
5-1	Study of the Relation Between the Actual Sitting Height of Men and Existing Headroom in Tanks.
5-2	Recording and Analysis of Noise Produced by Armored Vehicles.
5-3	Effect of Noise Upon Efficiency of Personnel.
5-4	Physiological Effects of Noise.
5-5	Study of the Course and Nature of Temporary Deafness Caused by Tank Noise.
5-6	Study of Course and Nature of Temporary Deafness Caused by Firing from Tanks.
5-7	Habituation to Tank Noise.
5-8	Estimation of the Practical Significance of Tank Noise.
5-9	Characteristics of Driving Controls in Relation to Efficiency of Use and Crew Fatigue.
5-10	Characteristics of Turret Controls in Relation to Efficiency of Use and Crew Fatigue.
5-11	Determination of Physical Characteristics and Range of Variability in Armored Force Personnel.
5-12	Seating Design and Placing in Relation to Fatigue.
5-13	Appraisal of Kind andDegree of Physical Effort Required of Tank Crews in Relation to Fatigue.
5-14	Study of Optimal Positioning of Visual Devices.
5-15	Characteristics of Vibrations in Tanks.
5-16	Effects of Vibration in Tanks Upon the Use of Tank Controls and Efficiency of Crew.
5-17	Study of Interfering Protrusions on Tanks.
5-18	Study of Design and Location of Padding in Tanks.
5-19	Survey of Tank Accidents and Their Causes in Relation to Tank Structure.

CREW FATIGUE RESEARCH

PROJECT NO. 5

(Cont'd.)

Sub-Project	Title
5-20	Study of Schedules, Duration and Discipline of Rest Periods for Tank Crews on Long Marches.
5-21	Measurement of Energy Expenditure of Personnel in Armored Vehicles.
5-22	Influence of Vibration Upon the Development of Fatigue.
5-23	Effects of Drugs and Dietary Supplements Upon the Development of Fatigue.
5-24	Determination of the Total and Specific Dietary Requirements for Varying Degrees of Physical Labor.
5-25	Measurement of the Efficiency of Performance and Rate of Development of Fatigue When on Emergency Rations.
5-26	Study of the Relationship of Body Temperature to Efficiency of Performance and the Development of Fatigue.
5-27	Relationship of Neurocirculatory Asthenia to Fatigue.
5-28	The Effect of Varying Concentrations of Carbon Monoxide on Efficiency and Fatigue in Tank Crews.
5-29	Development of Tests to Evaluate the Physical Fitness of Men.
5-30	Determination of the Changes in the Physical Fitness of New Selectees Throughout the Period of Basic Training.
5-31	Development of Skill Coordination Tests for Drivers, Gunners and Loaders in Tanks.
5-32	Bendix Power Control Tank - Driver Fatigue.

VISION IN TANKS

PROJECT NO. 6

Sub-Project	Title
6-1	Determination of the Visual Requirements for Various Tasks in Armored Vehicles (Spotting, Gunnery, Driving, etc.)
6-2	Study of the Characteristics and Limitations of Present Visual Devices in Tanks.
6-3	Study of Means for Improving Periscopes.
6-4	Study of Means for Improving Sighting Telescopes.
6-5	Investigation of Short-base Range Finders.
6-6	Investigation of Periscopic Binocular Spotters.
6-7	Investigation of All-around Periscopic Visual Devices.
6-8	Study of Methods for Protection of Optical Surfaces from Moisture and Mechanical Damage.
6-9	Study of Methods for Reducing Reflection from Exposed Optical Surfaces.
6-10	Investigation of Methods for Tank-to-Tank Communication.
6-11	Investigation of Methods for Detection of the Enemy.
6-12	Investigation of Methods for Discovery of Camouflage of Tank Crews.
6-13	Investigation of Range-Finding by Short-Wave Methods.
6-14	Investigation of Methods of Range Findings by Modulation of Infra-Red Rays.
6-15	Study and Development of New Instruments for Indirect Fire Control.
6-16	Investigation of Methods for Selection of Personnel for Range-Finding.
6-17	Development of Instruments for Testing, Scoring and Training Range-Finder Operations.

NIGHT VISION FROM TANKS

PROJECT NO. 7

Sub-Project	Title
7-1	Determination of the Lighting Requirements for Various Tasks of Tank Crews.
7-2	Determination of the Intensity, Distribution and Type of Illumination in Tanks Least Disturbing to Dark Adaptation.
7-3	Investigation of Methods of Improving Night Vision in Tank Crews by the Use of Eye Appliances.
7-4	Determination of Role of Diet and Food Supplements in Improving Night Vision.
7-5	Establishment of Criteria and Methods for the Selection of Crews for the Night Operations.
7-6	Study of the Relationship between Visual and General Fatigue.
7-7	Investigation of the Effects of Gun Fumes on Night Vision and Dark Adaptation.
7-8	Comparison and Evaluation of Field and Laboratory Methods of Measuring Night Visual Acuity.
7-9	Study of Light Transmission through Instruments at Night and its Range of Visibility.
7-10	Study of Brilliance Values and Contrasts of Sky and Countryside at Low Levels of Illumination.
7-11	Investigation of Recognition Thresholds at Low Light Levels with Various Background.
7-12	Investigation of Methods of Improving Recognition of Objects in Early Morning and Late Afternoon.
7-13	Study of Gun Flash and Measurement of its Effect on Dark Adaptation.
7-14	Investigation of Method for Screening out Gun Flash.
7-15	Study of Visibility of Tanks Against Various Backgrounds under Varying Conditions of Illumination.

NIGHT VISION FROM TANKS

PROJECT NO. 7

(Cont'd.)

Sub-Project	Title
7-16	Study of the Effects of Wear and Dust on Periscopes on Visibility at Night.
7-17	Study of Instrument Illumination and its Effect upon Fatigue.
Project 8	Preselection Tests
Project 9	Anthropometric Measurements of Armored Force Personnel.

Some Medical Problems of the Armored Force and the Need of Facilities for Investigation and Research

Resume of Discussions and Opinions of the
Committee on Industrial Medicine of the National Research Council
Meeting, Washington, D.C., on October 10, 1941

The Committee on Industrial Medicine of the National Research Council, at its meeting held October 10, 1941, National Research Council, Washington, D. C., considered problems of the Armored Force that are related to the safety, health, and efficiency of the personnel of this force of the Army. Particularly, attention was given to the nature of the problems and facilities for dealing with them.

It is to be understood that this action of the Committee and any report thereof, in no way infers laxity or criticism of the attention that has been given to these problems. On the contrary, the Committee is aware that the Armored Force is cognizant of the problems and their importance and is desirous of having them solved. The purpose of the Committee is primarily to review the problems of this Force from the viewpoint of the need of research and development. During the course of the discussions, some specific or detailed suggestions were made regarding the importance of problems and possible means for their solution. It should be realized that in many instances, these fall into the category of "helpful suggestions". The desirability of including them into a plan of investigation and research will be dependent on more careful study and more information on the cause, effect, and magnitude of the environmental factor or influence to be delt with together with a consideration of practicability and compatibility with the mechanics and practices of tank design and operation.

A resume of some of the problems and the points of consideration with opinions and conclusions reached by the Committee follows:

Problems of Safety, Health, and Efficiency of Personnel:

Toxic Gases In addition to the possibilities of the toxic gases and smokes of chemical warfare, tank personnel are exposed to carbon monoxide from the engine exhaust gas and from powder gases, and possibly to significant amounts of oxides of nitrogen from powder gases. As the exhaust gas from internal combustion engines that use gasoline as a fuel may contain under ordinary conditions of operation from approximately 3.0 to as high as 10 or 12 per cent by volume of carbon monoxide, and since as little as 0.03 to 0.04 per cent carbon monoxide in air will cause headaches and impairment of physical and mental function after several hours exposure, with 0.10 to 0.20 per cent producing disability and unconsciousness, it is apparent that carbon monoxide may be present in tanks in amounts that may be detrimental if not dangerous to the health, life and efficiency of the occupants. The carbon monoxide in the powder gases from operation of guns is a significant and additive source of trouble. There is some possibility that oxides of nitrogen may be present in amounts that are deleterious to health. The oxides

of nitrogen are highly irritating, and if present in sufficient quantities, they produce physiological and pathological responses that are similar in many respects to those of chlorine and phosgene.

Much work has been done on the response of persons to carbon monoxide; also, on ways and means for preventing exposure, such as general removal at the source, local ventilation, personal respiratory protection, and the use of detectors and alarms to indicate the presence of harmful amounts. The development of a device that will oxidize and remove the carbon monoxide from the exhaust gas before it escapes from the exhaust pipe has been practically completed. It appears that it would be possible to adapt some of these procedures to the control of carbon monoxide in tanks.

Dust The dust that is raised into the air by the operation of tanks over dry terrain or roads, can produce irritation of the eyes, nose and throat to a degree of discomfort and impairment of efficiency. Also, the possibility of breathing enough of this dust to produce the affection of the lung known as silicosis should be considered from the viewpoint of both actual damage and the probability of alleged damage in post-service claims for disability and compensation, especially in situations where it may be alleged that the exposure to dust was contributory to the occurrence of tuberculosis.

Considerable work has been done on the control of exposure to dust in industry. These include confinement or removal at the source, general ventilation or dilution with clean air, local or personal supplied of clean or cleaned air, use of dust collectors and traps, wetting procedures, and personal respiratory protection in the form of either mechanical filter or air-supplied respirators. These principles and practices offer possibilities for the solution of the problems of exposure to dust in tanks.

Vision Problems of vision in the operation of tanks are inherent in factors such as the "after effects" of gun flash, illumination, restricted openings for view, dust clouds, and other impediments. The importance of good conditions and facilities for vision to the maneuvering of tanks and to accuracy in the use of the gun makes the problems on this subject of vital importance.

There may be possibilities of improvement through the use of new types of lighting, the possible application of infra red, and the use of light screens and special optical or "viewing" equipment of either a general or personal nature.

Fatigue There are many factors that contribute either directly or indirectly to muscular and psycho-physiological fatigue of tank occupants, such as, the rigorous nature of the duties, the almost continual muscular strain and activity that is required to maintain physical equilibrium effects of posture and position, eye strain, breathing carbon monoxide, high temperatures and high humidities, noise and vibration. It is believed that by giving attention to the causative agents, these fatigue factors can be reduced to a degree that will produce a significant increase in efficiency and in the duration of effective function of the personnel.

Owing to the relation of fatigue to combat efficiency, it is apparent that the duration of effective performance of personnel should be determined for each individual personnel assignment in the various types of tanks and for different conditions of service, to serve as a guide to what performance may be expected in combat. The possibilities of dealing with the "fatigue factor" by rotation of personnel assignments or duties during a particular tour of action, or during successive tours, should be considered. This practice of job rotation has been used effectively in industry as a means for dealing with both fatigue and exposure to environments that are harmful to health.

Noise and Vibration Noise and vibration of parts are practically unavoidable in the design and operation of tanks. It is well recognized in industrial practices that these elements of environment are at least distractive and contribute to inefficiency, and that above certain levels of intensity, noise produces temporary, and in many instances, permanent impairment of hearing. The severity of the response depends primarily on the intensity and the duration of exposure.

The protection of persons from the effects of noise and vibration has received considerable attention by industry in recent years, beneficial results having been obtained by isolation or insulation of parts, physical damping, absorption media and personal protection.

Extremes of Temperatures The variety of problems of the Armored Force that may arise from extremes of temperature are apparent when it is considered that tanks may operate under climatic conditions that range from sub-zero temperatures to high temperatures and high humidities; also, with engine operations ranging from "still" to "wide open" and with personnel activity ranging from idle to strenuous work. Under one combination of factors, the prevailing temperature may be sub-zero with the personnel inactive and confined in the tank without the engine operating to produce heat. In another extreme, the air and ground temperature may be very hot, with the air in the tank made hotter by heat from the engine and the absorption of radiant energy from the sun; also, the effective temperature will be further increased by the increase of humidity of the air in the tank owing to the water given off by the occupants in the form of perspiration and with the breath.

Both of the extremes can present conditions for discomfort, inefficiency, and physical harm. It is believed that the cold situations can be dealt with by the use of means, such as, suitable clothing, chemical warming pads, and by the provision of heaters. If desired, heaters could be designed to operate either independently of engine operation, or take their energy from the engine, or a combination of these principles.

The hot situations are more difficult to deal with. There are, however, possibilities of improvement by using a combination of principles and procedures, such as, insulation, ventilation, direct air motion on the person to improve evaporation from the skin, use of dehumidifiers, wetting the outside surface of the tank(Australian water bag principle), use of color of paint that represents the best combination of camouflage and reflection of radiant heat, and radiant energy reflectors in the form of external covering of thin metal or fabric that provide an air space between the reflector and the tank.

Jarring, Jolting and Impact Owing to the nature of tank construction and the roughness of the terrain over which they may operate, the personnel are subject to jarring, jolting and impact with adjacent interior objects and structures. The resulting injury ranges in severity from minor to serious and may be fatal. Perhaps equally important, is the influence on general efficiency and fatigue, and the impediment of the jarring and jolting to the performance of duties, especially those of an exacting nature. Means such as padding, belts, harness and helmets for mitigating these effects have already been given much consideration. Other forms of equipment for personal protection are available; additional ones are conceivable.

Other Problems There are other problems of a similar or allied nature that should receive attention. Among these are the effect of "blasts", the removal and treatment of injured persons, and the development of special physical tests to determine the physical fitness and adaptability of persons for service in the Armored Force. Also, the foregoing resume pertains only to problems that have become apparent without much search. It is very possible that careful investigation and observation will reveal others. Further, it can be expected that new developments in equipment and new tactics will create new problems.

HEADQUARTERS ARMORED FORCE
Public Relations Bureau
Fort Knox, Kentucky

Visit of Research Committee
(Division of Medical Science)
of the
NATIONAL RESEARCH COUNCIL
to
Fort Knox, Kentucky, January 21, 1942

Members of Committee:

Dr. Clarence D. Selby, Chairman

Dr. Philip Drinker

Dr. E.C. Homblad

Dr. A. J. Lanza

Dr. George M. Smith

To be met at Brown Hotel, Louisville, 10 A.M., Jan. 21, by Col. A.W. Kenner, A. F. Surgeon
Lt. Col. T. Tupper, A.F., P.R.O.

Accompanied by:

A. L. Brooks, Engineer, Fisher Body

Dr. John Pendergast, Industrial Physician from Chrysler

Palmer C. Putnam, Tech. Aide, Nat'l. Defense Research Committee

Dr. Kenneth B. Turner, who will go to England as liaison officer between the two Research Councils

Col. J. S. Simmons, M.C.
Capt. C.S. Stephenson, M.C.

Time . . . . . . .Schedule of Activities ... Jan. 21, 1942 (Wed.)

8:45 A.M. Col. Kenner & Lt. Col. Tupper leave I Armored Corps Bldg. 1 Staff car.
10:00 A.M. Committee Meeting, Brown Hotel, Louisville
11:00 A.M. Entire party leaves Brown Hotel for Ft. Knox - 4 Staff cars.
12 Noon - Lunch at Central Mess
12:45 P.M. Leave Central Mess - to inspect Armored Force vehicles - motorcycle, peep, jeep, scout car,(wheel), half-track, 2 1/2 ton truck, ambulance, radio car, light tank, medium tank, trackless tank and self-propelled artillery.
Assembled at CP-6 for demonstration purposes. Demonstration: evacuation of light tank. One medium tank loaded with complete field equipment including ammunition.
1-3 P.M. Inspection at OP-6
3:15 P.M. Conference with Gen. Jacob L. Devers, Chief of Armored Force, at Force Hdqs.
4:00 P.M. Armored Force School - Exposition by Gen. S.G. Henry, School Commandant
4:15 P.M.-5:45 P.M. Inspection of Armored Force School

APPENDIX A
Part 3

NATIONAL RESEARCH COUNCIL
Division of Medical Sciences
acting for
COMMITTEE ON MEDICAL RESEARCH
of the
Office of Scientific Research and Development
****

COMMITTEE ON INDUSTRIAL MEDICINE

Minutes of the Meeting
January 21, 1942

The Committee on Industrial Medicine of the National Research Council convened at Hotel Brown in Louisville at 10 A. M. January 21, 1942, with Chairman Clarence D. Selby presiding.

Members of the Committee present were: Drs. Philip Drinker, E.C. Holmblad, A. J. Lanza, George M. Smith, A. L. Brooks, John Pendergast, Palmer C. Putnam, Kenneth B. Turner, and Col. A. W. Kenner, Lt. Col. T. Tupper, Col. J.S. Simmons, Major W.S. Stone and Captain C. S.Stephenson.

Here Col. Kenner presented instructive information regarding the history of Fort Knox, a discussion of the Armored Force School and a set of splendid pictures portraying the medical units as set up by the Armored Force. The group were escorted to Fort Knox and after luncheon at Central Mess were taken to Observation Post 6 where the following equipment was lined up for inspection and demonstration purposes: Armored Force vehicles, motorcycle, "Peep", "Jeep", scout-car (wheel) half-track, 2 1/2 ton truck, ambulance, radio-car, light tank, medium tank, trackless tank and self-propelled artillery. The various phases of this work were discussed by various members of the Staff and many questions discussed and answered. The evacuation of personnel from light tank and medium tank by both the turret and the front window methods were excellently demonstrated. The riding qualities of both the light and medium tanks with full complete field equipment were demonstrated to the members of the Sub-committee. The use of 1/2 ton cargo truck loaded with 15 litter patients was demonstrated to members of the Sub-Committee, and the ease of its riding qualities was attested by the members of the Sub-Committee. Demonstrations of loading such trucks with litter patients and the loading and unloading of the standard ambulances were made.

At 3:15 p.m. a conference was held with General Jacob L. Devers which was most instructive in presenting various phases of the problems of tank war-fare and those measures that are being undertaken to meet these problems.

From 4 until 6 P.M. General S.C. Henry, School Commandant lectured and conducted a tour through the Armored Force School demonstrating most excellently the full splendid instruction work being conducted in this school. Dr. A.J. Lanza, Dr. J. J. Pendergast and Professor Philip Drinker remained overnight and continued their observations and studies of tank warfare health problems. In a letter from Dr. Selby, January 23, 1942, addressed to Dr.E. H. Cushing, he states:

> "The General wishes immediate evaluation studies of carbon monoxide, dust, nitrous fumes, oil mists, and gasoline vapors incident to the use of tanks and to which tank crews are exposed - preferably to begin by January 26 and to be completed as soon as possible."

OFFICERS NOW ASSIGNED TO THE ARMORED MEDICAL RESEARCH LABORATORY

	From	Until
† * Bean, William B, Major, MC	August 1942	
Davis, George C, 1st Lieutenant, MC	September 1945	
Guest, George H, 2nd Lieutenant, MC	December 1945	
Hamilton, Eleanor B, Captain, WAC	January 1946	
† * Horvath, Steven M, Major, SnC	August 1942	
Lawson, Glasselle S, Captain, Inf.	March 1943	
Magee, Richard B, 1st Lieutenant, MC	September 1945	
Milburn, Conn L, Jr, Colonel, MC	January 1946	
Milstead, Valgene M, 1st Lieutenant, MC	September 1945	
* Nelson, Norton A, Major, SnC	July 1942	
Palmes, Edward P, 1st Lieutenant, SnC	December 1944	
Park, Charles R, Captain, MC	July 1944	
Shelley, Walter B, Captain, MC	April 1944	
Stickler, Charles E, 1st Lieutenant, MAC	March 1945	

OFFICERS FORMERLY ASSIGNED TO THE ARMORED MEDICAL RESEARCH LABORATORY

* Ashe, William F, Major, MC	June 1942	May 1944
* Blair, Edgar A, Major, Inf.	May 1942	January 1943
* Brackett, Frederick S, Lt. Colonel, SnC	August 1942	September 1945
Eichna, Ludwig W, Major, MC	October 1942	January 1946
Fisk, Frank W, Captain, CWS	June 1943	January 1946
** Freedman, Arthur, Captain, MC	February 1943	January 1946
* Hatch, Theodore F, Lt. Colonel, SnC	July 1942	September 1945
Henderson, Charles R, Captain, SnC	June 1944	February 1945
Hight, Janis, Captain, WAC	June 1944	October 1944
** Machle, Willard F, Colonel, MC	October 1942	October 1945
Mann, Wendell E, Captain, MAC	March 1943	September 1945
* Preston, Harold D, 1st Lieutenant, MAC	May 1942	April 1943
Rewwer, Erwin J, Captain, MAC	February 1943	August 1944
* Roberts, Lester D, Major, SnC	July 1942	October 1945
* Walpole, Robert H, Captain, SnC	August 1942	November 1945
Winters, Gertrude, 1st Lieutenant, WAC	June 1944	December 1945

* Members of the original staff.

** Associated with laboratory as a civilian prior to being commissioned.

† Pre-Army training and accomplishment of these Officers are given on the following pages as examples.

APPENDIX A
Part 4

PRE-ARMY TRAINING AND EXPERIENCE
of
Steven M. Horvath*, Major, SnC, AUS

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Research Activities:

Thirty papers have been published, mostly on man and his responses.

1. Ohio State Medical School	Endocrinology and Metabolism - Adrenals, Gonals and Pituitary
2. Woods Hole Oceanographic Institute	Comparative Physiology O_2 and CO_2 transport (blood)
3. Miami University	Continuation of above plus development physiology and physiology of exercise (man)
4. Harvard University:	
(a) Fatigue Laboratory Res. Ass.	Influence of Environmental Factors on Ability of Men to Work
(b) Metropolitan State Hospital for the Insane Director of Physiological Research	(1) Reaction to Shock Therapy (2) Aviation Physiology - Theoretical and practical application of "free fall" parachute jumps from high altitudes (3) Gerontology

Teaching Experiences:

1. Assistant in Medical Physiology (Ohio State Medical School - 2 years)

2. Instructor in Physiology (Miami University - 2 years)

3. Tutor - Biochemical Sciences (Harvard University - 3 years)

Education:

Oberlin College, Miami University (B.S.)
Miami University (Physiology and Genetics) (M.S.)
Harvard University (Physiology and Biochemistry) (Ph.D.)

* This Officer was Chief of the Physiology Section and later combined this position with that of Executive Officer of the Laboratory.

PRE-ARMY TRAINING AND EXPERIENCE
of
William B. Bean*, Major, MC, AUS

Research Activities:

Twenty-eight medical papers had been published on independent clinical research on heart disease, nutrition and peripheral vascular manifestations of hepatic disorders, pregnancy, and various medical conditions.

Teaching Experience:

Student Instructor in Anatomy	University of Virginia, School of Medicine 1932-35
Teaching Fellow	Thorndike Memorial Lab., Boston 1936-37
Assistant in Medicine	Cincinnati Medical College 1937-38
Instructor in Medicine	" " " 1938-40
Assistant Professor of Medicine	" " " 1940
Investigation and Teaching	Hillman Hospital and Nutrition Clinic 1940-42

Education and Training:

University of Virginia (English and Biology) (B.A.)- 1932
University of North Carolina (Chemistry and Physics)
University of Virginia School of Medicine (Medicine) (M.D.)-1935
John Hopkins Hospital (Medical Intern)- 1935-36
Assistant Resident in Medicine, Boston City Hospital - 1936-37
Senior Medical Resident, Cincinnati General Hospital - 1937-38
Fellow in Nutrition, Cincinnati Medical College- 1938-40

Medical Consultant:

Assistant Visiting Physician, Cincinnati General Hospital - 1940
" " " Hillman Hospital, Birmingham, Ala. - 1940-42

Medical Examiner:

Draft Boards, Cincinnati - 1941-42

* Chief, Hot Room Research - 1942-43
✓ Director of Medical Research - 1943-45
✓ Commanding Officer - 1945-46

APPENDIX A
Part 4

FOREIGN VISITORS TO ARMORED MEDICAL RESEARCH LABORATORY

Name	From	Date
Brigadier G.M. Ross	British Liaison	Mar., May, Sept.,1944 May, June 1945
Maj. Wimbush	do	March 1944
Maj. Cruikshank	Director General's Office, AMD V, Ottawa, Canada	April 1944
General Alberto Romero	Minister of Defense of Ecuador	do
Col. G. Colchester	British Army Staff	May 1944
Lt. Col. N. R. Grimston	do	do
Lt. Gen. Robert K. S. Lim	Chinese Army	June 1944
Col. Ewen Downie	Australian Military Mission	do
Capt. Mussen	British Admiralty Delegation	do
Capt. Neufeld	Royal Canadian Army Med. Corps	do
Maj. Gen. R. Briggs	Director, Royal Armored Corps	July 1944
Maj. Gen. F.H.W. Davidson	British Military Intelligence	do
Col. C.B. Bouchier	British Army Staff	do
Col. Enrique Vasquez Benavides	Director, Peruvian Army, Ordnance Service	do
Col. Manuel Odria	Sub-Director of the Peruvian Command and General Staff School	do
Col. Leopoldo Jarrin	G-3, The Peruvian General Staff	do
Col. Antonio Luna	Director, Peruvian Inf. School	do
Lt. Col. W. V. Blackley	RCAMC	do
Maj. Monroe	British Army	August 1944
Col. Keyes	do	do
Col. J.N.Berkeley Miller) Col. Chambers) Mr. Steeds)	British Army Staff, School of Tank Technology, Chobham, Surrey	Sept. 1944

APPENDIX A
Part 5

Foreign Visitors (Cont'd)

Lt. Col. Gaston Valliei) Maj. Jean Copi) Maj. Joseph Molinie) Maj. Demoreville)	Members of French Military Mission to the U. S.	Oct. 1944
Col. Doyle	British Army Staff	Sept. 1944
Capt. Merrillis	do	do
Col.Sir Stanton Hicks	do	do
Mr. Hobbs) Mr. Gordon) Mr. Beecher) Mr. Gardiner)	British Civilians (in connection with British Army Function)	do
Maj. Gen. A. H. Gatehouse	British Army Staff	Oct. 1944
Brigadier Dumphie	Royal Armored Corps	do
Col. P. C. Doyle	British Army Liaison	Oct. & Dec.'44
Col.J.N. Berkeley-Miller	British Army Staff	Oct. 1944
Maj. G. D. Meyrick	British Army Liaison	do
Col. P. G. Griffin	RCA, Camp Borden, Ont.	Dec. 1944
Lt. Col. M.T. Johnson	RCA, Camp Borden, Ontario General Staff, Training Dept.	do
Maj. D.A. Lander	RCA, Camp Borden, Ontario	do
Dr. K.S. Fisher	Camp Borden	do
Maj. Richard Hewitt	Royal Armored Corps Canadian Army, Camp Borden	do
Lt. Col. Ignacio De Freitas Rolin,Inf) Maj.Hoche Pulcherio, Art'l) Maj. Joao Gualberto Gomes de Sa, Inf.) Maj. Salm De Miranda, Cav.) Maj. Ernesto Geisel, Art'l) Maj. Adauto Esmeraldo, Art'l) Capt. Garaldo de Menezes Cortes, Inf.) Capt. Hugo Manhaes Bethlem, Cav.)	Brazilian Division Training Program	Jan. 1945

APPENDIX A
Part 5

Foreign Visitors (Cont'd)

Maj. Gen. Julio Pardinas) Maj. Gen. Modesto A. Guinant) Lt. Alfonso Arestegiu)	Mexican Army	June 1945
Field Marshall Sir Henry Maitland Wilson	British Army	do
Col. J.N. Berkeley-Miller	do	July 1945
Air Commodore F. C. Livingstone	Royal Air Force	Sept. 1945
Wing Commander S. R. C. Nelson	do	do
Maj. Gen. D. Lindsjo	SG, Swedish Ministry of Defense	do
Capt. Karl Eric Groth	Chief of Hospital Administration Swedish Ministry of Defense	do
Capt. R. A. Graff	Surgeon Royal Navy, London, Eng.	Oct. 1945

Note—No record of visitors to Laboratory was maintained prior to March [illegible].

Extract from letter by Col. Albert W. Kenner, Headquarters Armored Force, Office of the Armored Force Surgeon, Fort Knox, Kentucky, to Dr. E. H. Cushing, Division of Medical Sciences, National Research Council, Washington, D.C., dated 14 January 1942

"The need for our laboratory becomes more apparent every day, and I am hoping that some real action will soon be initiated. I knew if it ever got into Army channels, I would get it about the time of the Armistice. It was my understanding, that it would be constructed from funds made available by the O.P.M. (or something) on the O.K. of Mr. Bundy and the secretary. I was called upon to submit plans and estimates by the Surgeon General's Office, which fortunately, I had at hand, so there is no excuse for anything more than the usual haggling with G-4."

PRINCIPLES FOR GUIDANCE OF RESEARCH AND DEVELOPMENT AGENCIES
RESPONSIBLE FOR MILITARY VEHICLES

INTRODUCTION: The war time period of empirical research and improvisation under the acute urgency of limited time should be followed by a less hurried and more systematic approach to all problems. This means a re-evaluation of current doctrine on development and design, a comprehensive survey of tactical employment of arms and equipment, and collection and digestion of fundamental data bearing on questions within the scope of the several research and developmental agencies dealing with the problems. For practical purposes a program might be set up with two objectives: (1) a review of present equipment to introduce improvement in materiel on hand in case of its need within 3-5 years and (2) a definition of principles which should be incorporated in the long term plans for design and employment. This will, in effect, permit rapid improvements but will not restrict future changes by confining them to lines of development now under consideration. Specifications laid down should thus be guided by two principles: (a) what can be done to improve existing equipment and (b) what types of changes should be considered in terms of the more distant future.

Whatever the final policy regarding the groups responsible for design and for testing, a logical pattern of approach to such problems as atmospheric control of military vehicles can be defined at present. Four considerations must be studied for all types of military vehicles.

1. The source of the condition or hazard - where it comes from and what it is.

2. The methods of preventing, reducing or eliminating the hazard.

3. The permissible limits to which the environmental factor be allowed to deteriorate, without reducing efficiency or causing a dangerous condition in personnel. A definition of optimal conditions is desirable.

4. Actual dangers or reduction in comfort and efficiency which result from failure to prevent, reduce, or remove the harmful condition.

Such as approach, by resolving each phases of the problem into its simplest components, must be considered in practical terms by those responsible for the design and production of vehicles, for it is well known that the vehicle cannot fulfill its mission if any single factor such as personnel comfort, fire power, armor, automotive power or whatnot is allowed to dominate design. All desired features must be judged in relation to the whole which must be balanced and integrated in the light of practical considerations. On the other hand it may be possible to correct or prevent a number of atmospheric hazards by the employment of a single principle; for example, positive pressure ventilation which, under ideal circumstances, should take care of gun and motor fumes, heat or cold, dust, moisture and chemical warfare agents. Thus the multiple utility of a single device may permit considerable advances in safety and comfort of personnel.

It must also be recognized that it is undesirable to set acceptable limits too close to physiologically tolerable limits. Combat troops are subject to many deficiencies (inadequate rest, food, water, and relaxation) and hazards (toxic

fumes, emotional tension, fatigue, injuries, blood loss, and shock) which acting in unison, lower his tolerable limits below those of non-combat or garrison troops upon whom most of the present limits have been based. If a combat soldier is to be given a reasonable and fair chance to survive injuries and wounds it is desirable that a good margin of reserve and safety be provided in setting up the acceptable limits of each of the undesirable factors to which he is exposed. These principles have been followed in setting up the tolerable limits detailed in the body of the report.

CITATIONS AND AWARDS

The following lists the awards and citations affecting the Laboratory and personnel:

<u>14 December 1945:</u>

Meritorious Service Unit Plaque awarded Laboratory -
See AMRL File No. 201.22

<u>30 April 1943:</u>

Legion of Merit awarded Technical Sergeant Adam Assman -
See Assman File No. 201.

<u>December 1945:</u>

Legion of Merit awarded Col. Willard Machle, Lt. Cols. Brackett and Hatch -
See AMRL File No. 201.22

<u>January 1946 -(New Year's Honors):</u>

O.B.E. awarded Col. Willard Machle

RESULTS OBTAINED FROM RECOMMENDATIONS MADE

ON PROJECT REPORTS

IN ARMORED MEDICAL RESEARCH LABORATORY

APPENDIX B

OPERATIONS AT HIGH TEMPERATURES

Project No. 2 - High Temperatures in Tanks. Final Report on Sub-Project 2-6, Determination of Water and Salt Requirements for Desert Operations, 20 May 43.

RECOMMENDATIONS:

a. Water Requirements.

(1) That the following daily requirements for drinking water be used as a guide in determining supply of water to troops in desert areas.

Activity	Illustrative Duties	24-Hour Fluid Requirements (Qts. Per Man) When Maximum Daily Temperature is:		
		95°F	105°F	115°F
Light to Moderate work	(Desk work, (Tank operation over smooth terrain	4	6	10
Moderate work	(Tank operation over rough terrain, (Marching at normal rate	5	7	11
Strenuous work	(Engineers' operations, (Forced marches, (Entrenching operations	7	9	13

(2) That the above allotments be increased by one (1) quart per day when the K-ration is used.

(3) That additional water be issued for vehicles, for cooking, and for toilet purposes so that the above water ration may be reserved for drinking.

b. Salt Requirements.

(1) That one (1) gram of extra salt be taken for each quart of water consumed. The following methods of administration may be used:

(a) Adding extra salt in the preparation of food.
(b) Using extra salt at mess.
(c) Addition of salt to drinking water in the following proportions: 1/4 teaspoonful per quart, two 10-grain tablets per quart, or 0.3 pounds in 36 gallons (Lyster Bag). This is the method of choice when above methods of salt administration are not practical.
(d) Direct ingestion of salt tablets is not recommended. They should be dissolved in the drinking water as directed in (c) above.

(2) When no food is taken, it is imperative that salt be taken with water.

(3) When no water is available, or where the supply is reduced, extra salt should not be taken.

ACTION:

These recommendations incorporated into Circular Letter 119, Office of Surgeon General, 3 July 1943. Subject: Acclimatization, Included Water and Salt Requirements of Troops in Hot Climates. Circular 136, Office of Surgeon General, 28 July 1943, Treatment of Heat Stroke, Heat Exhaustion and Heat Cramps. Also formed basis of T.B. Med 175, Prevention and Treatment of Adverse Effects of Heat, June 1945.

Project No. 2-7, 2-11, 2-13, 2-15, 2-17, 2-19, 18 October 1943 - Determination of Water and Salt Requirements for Jungle Operations, Influence of High Temperatures Upon the Efficiency of Personnel, Effect of Training Upon the Efficiency of Performance of High Temperatures, Study of the Effects of Drugs and Accessory Food Factors on Efficiency of Personnel at High Temperatures, Study of the Physiologic Effects of High Temperatures, Study of Efficiency of Performance and Rate of Deterioration Under Conditions of Water Limitation, Study of Men in Simulated Jungle Heat.

RECOMMENDATIONS:

a. Troops brought into a hot tropical or jungle theater should, when possible, have at least two weeks of acclimatization under supervision. Supervising officers and NCO's should be thoroughly familiar with the principles embodied in this report.

b. During acclimatization, graded amounts of work should be done with carefully regulated exposures during the worst periods of the day.

c. Enough water should be drunk to satisfy thirst at all times. When water intake is inadequate for their needs men lose morale and work ineffectively and inefficiently.

d. Exposure to sun should be limited to that necessary for the care and drying of the skin and clothing.

e. All personnel should be familiar with the signs and symptoms of heat exhaustion, and should be indoctrinated in methods of preventive and emergency treatment. These have been described previously (see Report on Studies of Men in Simulated Desert Heat, Project 2 (2-11,12,13,17), file 727-2, April 3, 1943).

f. All officers should realize that the daily water and salt requirements of their men are large and that these requirements approach those for men working in desert environments. (See Final Report on Determination of Water and Salt Requirements for Desert Operations, Project 2-6, file 333-34, May 20, 1943.)

g. Alcoholic beverages should be prohibited in regions of activity in tropical theaters.

h. Since rigid hygienic measures are necessary to control skin rashes and fungus infections of the feet, particular attention should be directed to care of the skin.

i. Men recently ill should not be exposed to tropical heat before they have made a complete recovery from their illness and regained good physical condition. Frequently they will have to be reacclimatized.

j. Short periods away from extremes of heat and humidity should be provided where feasible.

ACTION:

See action on Project No. 2 on preceding page.

<u>Project No. 2-8, 9 October 1942</u> - Evaporative Ambulance Cooler.

RECOMMENDATIONS:

On stopping after running with the cooler in operation, patients should be removed from the ambulance as soon as feasible sine, in a few minutes, because of rise in both temperature and humidity, the ambulance atmospheric conditions become less comfortable than the outside.

Relief cooling should not be expected when the relative humidity is high.

Used as it is, in a region of low humidity, the cooler is an efficient and useful aid.

ACTION:

Recommendations followed and service ambulance equipped with evaporative coolers.

<u>Project No. 2-8, 20 October 1942</u> - Effect of Desert Conditions on Personnel.

RECOMMENDATIONS:

a. When troops are moved into the desert they should be given a period of from three days to one week for acclimatization during which they do very little heavy work. Activity should increase gradually.

b. Soldiers convalescing from any moderately severe illness should not be sent to the desert.

c. The increased salt needs should be satisfied by increased salt use in cooking and at meal time to insure an intake of 20 grams daily and/or by the addition of salt to drinking water to a concentration of 0.1%. Salt tablets produce vomiting in enough cases to interdict their general use.

d. Use of alcohol should be restricted among desert troops, at least during the early period of adaptation.

e. Careful instruction should be given troops and medical officers concerning the effect of heat on men and the increased needs for water and salt. A short course for indoctrination with lectures and movies should be considered.

f. Physical work done in the cooler parts of the day, early morning and late evening, and particularly at night is much more economical of water and when water supply is a problem much could be conserved by working at night. The middle of the day should be a period of inactivity insofar as is possible.

g. Studies of differences in adaptability and capacity to work among negro and white personnel will be made.

ACTION:

See action on Project No. 2 on page 2.

Project No. 2-11, 2-13, 2-17, 2 October 1944 - Influence of High Temperatures Upon the Efficiency of Personnel, Effect of Training Upon the Efficiency of Performance at High Temperatures, Study of the Physiologic Effects of High Temperatures.

RECOMMENDATIONS:

a. The essential information in this report be made available in the form of a circular to:

(1) All line and medical officers, particularly of armored units, operating or preparing to operate in hot climates.

(2) Agencies concerned with the design and manufacture of closed combat vehicles.

b. Men working in hot environments which approach the upper limits be allotted and encouraged to drink from 2 to 3 quarts of water per hour during the period of work.

ACTION:

No circulars made available.

Project No. 2-11, 2-12, 2-13, 2-17, 3 April 1943 - Influence of High Temperatures on the Efficiency of Personnel, Study of Methods of Attaining and Maintaining Acclimatization to High Temperatures, Effect of Training on the Efficiency of Performance at High Temperatures, Study of the Physiologic Effects of High Temperatures. Studies of Men in Desert Heat.

RECOMMENDATIONS:

a. Troops brought to a hot desert should when possible be given at least a four day period for acclimatization, during which time they should be supervised carefully by medical, line and non-commissioned officers.

b. Graded amounts of work should be done during acclimatization with regulated exposure to heat during the midday hours (Appendix I, Schedule 1).

c. Enough water should be drunk to satisfy thirst at all times. If more water is drunk during the first three days than is dictated by thirst alone, work will be accomplished more efficiently.

d. Unnecessary exposure to sun should be avoided. It increases the water requirement, adds to the danger of heatstroke and may cause serious sunburn.

e. All personnel should be familiarized with the signs and symptoms of heat exhaustion and should be instructed in methods of emergency treatment (Appendix I).

f. All officers should be made familiar with the water and salt needs of their men and be acquainted with the information given in the Appendices.

g. For one week before and after entry into a hot desert troops should be given adequate rest and alcohol should be prohibited. Men who have had recent illness should not be exposed to heat until they have completely recovered (and are back in good physical condition).

ACTION:

See action on Project No. 2 on page 2.

Project No. 2-3, 2-18, 24 November 1943 - Test of the Adequacy and Ranges of Use of Clothing for Jungle Operations, Effects of Impregnated and Impervious Clothing Upon the Efficiency of Personnel.

RECOMMENDATIONS:

a. That all clothing to be issued for jungle operations be tested on standardized test subjects before acceptance, to determine the physiological burden which is imposed upon the wearer.

b. That all jungle clothing (wool excluded) be thoroughly laundered before use in hot humid environments.

c. When the military situation permits, and when there are no hazards from fauna, flora or solar radiation, men in hot humid climates be permitted to work in minimum amount of clothing.

ACTION:

Recommendations "a" and "c" were accepted and are in use. Recommendation "b" was not followed.

Project No. 2-26, 27 April 1943 - Test of Individual Crew Conditioning System.

RECOMMENDATIONS:

That the suit be considered adequate for individual cooling under all conditions likely to be met with Armored Force personnel. (The question of the actual need for the suit is discussed in the Appendix).

ACTION:

Suit was discarded.

Project No. 2-29, 13 May 1943 - Test of Truck, 3/4 Ton, Refrigerated Ambulance.

RECOMMENDATIONS:

a. That subject vehicle be considered adequate for transportation of casualties in climates where ambient temperatures above 100°F with low humidity are encountered.

b. Greater refrigeration capacity be provided for use in tropical climates where high relative humidities are encountered.

ACTION:

No further development for procurement of refrigerated equipment for ambulances is known by this Laboratory.

Project No. 2-22, 8 March 1944 - Determination of the Amount of Heat Transmitted to the Fighting Compartment of Tanks Under Field Conditions.

RECOMMENDATIONS:

a. That field experience with respect to the heat problem in tanks operating in Pacific areas be obtained for study to determine the need for further improvement in tank ventilation and crew cooling.

b. That the study and development of individual crew cooling methods, now being conducted by Ordnance, be actively pursued.

ACTION:

Observers were sent to the Phillippines but too late to be of any value.

Project No. 22, 28 December 1943 - Test of Hammock, Jungle, Impregnated with "Preventol G-4".

RECOMMENDATIONS:

a. Hammocks, Jungle, impregnated with "Preventol G-4" be considered safe for use so far as danger of dermatitis is concerned.

b. Tensile strength of the end spreader-ropes in saturated atmospheres be checked for adequacy.

ACTION:

Recommendations followed.

Project No. 2-24, 11 May 1943 - Study of Methods of Reducing the Heat Load In Tanks.

RECOMMENDATIONS:

That a paint for exterior surfaces of tanks be developed to give the maximum possible reflection of solar energy, consistent with the requirements for concealment.

ACTION:

Investigation for improved solar reflecting paints was in progress by several agencies at close of hostilities.

Project No. T-11, 27 September 1945 - Test of Heat Load Imposed By Clothing Treated To Repel Insects and Arachnids.

RECOMMENDATIONS:

That if the Chemical Warfare Service tests in progress indicate that this impregnation is not lost by continued wear and laundering, and does not produce a serious dermatitis, these insect repellent garments be considered suitable for issue.

ACTION:

None at present time.

Project No. T-2, 21 September 1945 - Ventilation Requirements of a Ventilated Suit. Test of Heat Load Imposed By Protective Clothing.

RECOMMENDATIONS:

a. That provision be made for a maximum air flow of approximately three (3) pounds per minute with lowest possible water content below 60 grains per pound of dry air.

b. That provision for individual adjustment of air flow for each suit be provided.

c. That for further improvement of the suit additional studies be conducted to determine the best internal distribution of the ventilating air.

ACTION:

These recommendations were followed, although actual number of suits built was not known.

Project No. 16, 4 February 1944 - Effect of Insulation of Transmission and Final Drive Upon the Heat Load Within Tanks.

RECOMMENDATIONS:

a. That an insulation blanket be considered satisfactory for use in M4 Medium Tanks operating in areas where high ambient temperatures and humidity exist.

b. That installation of insulating blankets be made at intermediate tank depots for all tanks being shipped to the South, Central and Southwest Pacific Theaters.

c. That the blanket be designed for easy installation and removal and provided with surface protection against absorption of oil, water and chemical warfare agents.

d. That the possibility of further improvement in blanket design be investigated.

ACTION:

A limited quantity of insulated blankets was procured for test purposes essentially for shipment to the Southwest Pacific eighteen months following this reported recommendation. A few are known to have reached the Pacific Theater shortly before cessation of hostilities.

COLD WEATHER OPERATIONS

The experimental work on cold weather was primarily devoted to basic research. This was due to the paucity of available knowledge and the need to clarify the background picture of man's responses to cold. Therefore only a minimal amount of practical work was performed. It became clear that no real understanding of the problems encountered in cold weather operations could be had until more work was done on the physiology of cold.

<u>Project No. 1-1, 2 June 1944</u> - Test of the Adequacy and Ranges of Use of Winter Combat Clothing.

RECOMMENDATIONS:

a. No specific recommendations are made. Attention is called to the practical finding of this study that the thermal experiences of subjects dressed in Arctic issue clothing are not in accord with the predicted behavior and, as a consequence permissible tolerance time was found to be markedly less than anticipated. The basic reasons for this departure from anticipated results requires further investigation by clothing designers.

ACTION:

None

<u>Project No. 1-1, 1-4, 1-5, 1-6, 18 January 1943</u> - Partial Report, The Adequacy and Ranges of Use of Winter Combat Clothing.

RECOMMENDATIONS:

a. That the present Winter Combat Uniform with modifications, be retained pending the initiation and completion of experimental studies on new models. This recommendation is extended since the difficulty with the present suit lies primarily in the inadequate protection of the extremities.

b. That types of clothing other than those now issued be investigated for their suitability to the needs of the Armored Force when operating in sub-freezing environments.

c. That when arctics are worn, arctic socks and innersoles be substituted for GI shoes which are contra-indicated during cold weather.

d. That medium length arctic sock or equivalent be standardized.

e. That until more complete studies are carried out, the present winter combat uniform be modified in the following respects:

(1) Provision be made for defecation and urination without excessive exposure being necessary.

(2) That openings be provided on the left side of the trousers similiar to those on the right.

(3) That zipper tabs be provided with thongs that can be handled with gloved hands.

(4) That a suitable fastener be provided for the chin strap on the combat helmet. Fasteners of metal should not be in contact with the skin, and should be capable of being easily fastened with gloved hands. (Note: Winter Operations Board urgently requested this change 10 months ago!)

f. That the following changes be made in the parka, alpaca lined:

(1) The belt be attached.

(2) The zipper be provided with thongs.

(3) The facepiece be provided with fasteners capable of being easily fastened with gloved hands.

(4) The present breast pockets be lined with alpaca or other material to provide auxillary protection for the hands.

(5) Additional pockets in the lower portion be added.

ACTION:

Recommendations followed.

<u>Project No. 1-1, 1-18, 10 April 1944</u> - Study of the Methods for Selection of Men for Cold Weather Operations.

RECOMMENDATIONS:

No specific recommendations are made. Attention is called to the need in clothing testing for proper pairing of subjects in accordance with their sensory reactions to cold. The need for further study of the stimuli which effect the sensory experience of cold is also indicated.

ACTION:

None.

<u>Project No. 1-10, 11 July 1944</u> - Analysis of Position of Armored Force Personnel in Respect to Winter Protection with Recommendations for Use and/or Design of Suitable Equipment and Food.

RECOMMENDATIONS:

a. That padded bucket seats of the type now installed in the M-4 Tank, or equivalent be considered for adoption for other vehicles employed in cold weather operations.

b. That some means be found which will keep insulating pads attached to seats.

ACTION:

No positive action taken.

Project No. 1-22, 3 May 1943 - Outfit, Combat, M-1943, Experimental Test No. OQMG-140.

RECOMMENDATIONS:

a. That the articles of the temperate zone issue Outfit Combat M-1943 found suitable be considered for use by the Armored Force.

b. That the articles found to be unsuitable in their present form be reconsidered by the Armored Force after the correction of present defects.

c. That the articles found to be unsuitable, not be considered by the Armored Force.

ACTION:

These recommendations became the basis of additional work by the Office of Quartermaster General cold weather clothing.

Project No. 1-23, 29 April 1943 - Test of Raincoat with Parka Hood; Poncho; Rainshirt, Knee Length Raincoat, Synthetic Resin: and Tent Poncho Sectional.

RECOMMENDATIONS:

a. That the Raincoat with Parka Hood be considered suitable for use by the Armored Force.

b. That consideration be given to the inclusion of an extra length of material to be attached by means of snaps to the back of the raincoat, in order to provide sufficient length for use of the coat as a ground sheet.

ACTION:

No action.

Project No. 11, 30 September 1943 - Test of Clothing, Battle, Four-Zone (OQMG-214), Cold and Arctic Zone Issues.

RECOMMENDATIONS:

a. That the cold and arctic zone issues of Clothing, Battle, Four-zone be considered for adoption by the Armored Command in preference to the Outfit, Combat, Winter.

b. That investigations be continued with a view to improvement of protection for the extremities by foot gear and gloves of improved design.

c. That, if possible, clothing for the trunk be designed to provide for greater ease of ventilation during work.

d. That the chamois mask be considered unsatisfactory for use.

ACTION:

Recommendations "a" and "b" favored, however, after considerable delay. "c" and "d" received no action.

Project No. 20-4, 24 May 1944 - Immobilized Air (O.QMG Test Number 57-IV)

RECOMMENDATIONS:

a. That the proposed method of napping of garments not be considered a satisfactory means for enhancing the insulating value of clothing.

ACTION:

No action.

Project No. 20-2, 1 June 1944 - The Insulation Provided by Windbreaks (OQMG Test No. 57-II)

RECOMMENDATIONS:

That windproof garments be made from fabrics having an air permeability of at least 10 cu. ft./sq.ft./min., which provides satisfactory protection from winds up to nine and six tenths (9.6) miles per hour.

ACTION:

No action.

Project No. 20-1, 14 June 1944 - The Effect of Leakage from Closures Upon Thermal Protection. (OQMG Test Number 57 I-A).

RECOMMENDATIONS:

a. That the zipper fly-front 9 ounce sateen parka and zipper fly-front pile parka be considered for adoption to replace the present standard non-opening items.

b. That the present garment closures do not need to be improved.

ACTION:

No favorable action.

Project No. 1-11, 25 May 1944 - Influence of Cold Upon the Efficiency of Personnel.

RECOMMENDATIONS:

a. That in design, additional emphasis be placed on the capacity of hand wear combinations to maintain dexterity and functional efficiency of the hand and fingers.

ACTION:

No action.

Project No. 1-19, 16 June 1943 - Study of the Physiological Effects of Cold.

RECOMMENDATIONS:

a. No specific recommendations are made.

b. This report is being distributed to agencies concerned with the testing of clothing and equipment.

ACTION:

No action.

Project No. 1-20, 9 December 1942 - Study of the Heat Retaining Capacities of Insulated Jugs.

RECOMMENDATIONS:

a. That insulated thermos jugs up to five-gallon capacity be purchased for test in the field during winter operations.

b. That manufacturers be contacted regarding the possibility of constructing an insulated thermos jug on the general plan of the present water container.

ACTION:

Recommendations are not approved. No containers were obtained.

Project No. 1-20, 18 February 1944 - Heat Retaining Capacities of Insulated Jugs.

RECOMMENDATIONS:

That food containers with "Santocel" insulation and improved design be subjected to field tests.

ACTION:

Quartermaster was to start making these but none have appeared for test.

Project No. 1-21, 20 March 1943 - Test of Electrically Heated Gloves.

RECOMMENDATIONS:

a. The electrically heated gloves as submitted for test be considered unsatisfactory for use by the Armored Force.

b. Suitable modifications as recommended in par 4, Appendix "A", be made by the manufacturers.

c. The modified gloves be tested both in the field and the Laboratory prior to a final decision relative to their adoption.

ACTION:

No action.

Project No. 2-5, 22 October 1942 - Test of Adequacy of K-2 Ration in the Desert.

RECOMMENDATIONS:

a. K-Ration

(1) U. S. Field Ration K-2, modified for Desert Warfare is an excellent emergency ration for Desert Warfare operations of the Armored Forces.

(2) With certain suggested changes, U. S. Field Ration K-2 modified for Desert Warfare is recommended as a reserve and emergency ration.

b. Change the K-1 and K-2 biscuit. They were eaten by less than half of the men. Saltines, soda crackers, cheese crackers, graham crackers or sweet wafers might be tried.

c. Change the packaging. Put cigarettes and gum outside of the individual units. Napkins might be added, especially to remove the liquid grease which may spurt from the meat tins.

d. Change the cheese from the supper to the lunch unit.

e. Cocoa, a great favorite, should be substituted for the powdered soup.

f. Add a fruit bar, or some laxative when the ration is to be used for several days.

ACTION:

The recommendations were followed and as a consequence of this test additional field trials of rations were instituted. See later reports.

Project No. 1, 1-7, 1-15, 2-5, 2-14, 10 April 1944 - A Critique of Army Rations: Acceptability and Dietary Requirements.

RECOMMENDATIONS:

a. If an emergency ration is being used for more than a week at a time, it should be modified in accordance with the specifications in Appendix "B", Table 1.

b. Testing of rations in non-combatant zones should be validated by tests in combat theaters.

c. The determination of acceptability, adequacy and use of rations should be a Medical Corps as well as Quartermaster Corps function.

ACTION:

All recommendations were followed and as a consequence, surveys were instituted on the value of various rations. Teams from the laboratory were engaged in these surveys in the P.O.A. and S.W.P.A. Unfortunately the S.W.P.A. survey took place quite late in the war.

Project No. 30, 22 November 1944 - Test of Acceptability and Adequacy of U. S. Army C, K, 10-in-1 and Canadian Army Mess Tin Rations. (Final Report)

RECOMMENDATIONS:

a. General --

(1) All packaged expeditionary rations be packed so that the maximal variety is contained in the standard bulk package. Carload lots of a ration containing no variation should never be used as the only source of supply to a unit. This should be incorporated into the ration specifications.

(2) C, K and 10-in-1 Rations be issued automatically up to 1½ rations per man per day without the authorizations and medical concurrence now required. Above these levels of issue the usual regulations will hold.

(3) Consideration be given to the following in all rations. Jam increases the consumption of biscuits; and canned milk and adequate sugar increase the consumption of coffee.

(4) Every effort be made to have packaged rations consumed in as fresh a state as is compatible with the logistics of the strategic and tactical situation.

b. C-Ration --

(1) Remove M-1, -2 and -3 items and ham-egg-and-potato. Retain the components and variety of the Experimental C Ration.

(2) Improve cans by eliminating the side-opening.

(3) Include sweet-center cookie.

(4) Add jam or other spreads.

(5) Retain new types of biscuits.

(6) Increase issue of coffee.

(7) Include the utility pack.

c. K-Ration --

(1) Add jam.

(2) Eliminate K-1A and K-2 biscuits and retain other types tested.

(3) Reduce quantity of cheese but retain varieties.

(4) Eliminate bouillon and increase coffee issue.

(5) Add other meat components for variety.

(6) Add cocoa.

d. Canadian Army Mess Tin Ration

(1) If use for more than a short period is considered, increase available riboflavin by varying sardines with other fish; improve opener for can; improve packaging and stability of milk-and-sugar-powder, packaging of cheese, and stability of butter.

(2) Increase issue of coffee and sugar.

e. 10-in-1 Ration

(1) Include sugar with Menu #2

(2) Increase availability of Vitamin C by distribution into additional components.

(3) Reduce issue of dehydrated products or improve their acceptability.

(4) Increase proportion of fruit beverages other than lemon powder.

(5) Increase issue of coffee.

(6) Increase issue of canned milk.

(7) Eliminate the K Ration noon meal and replace with acceptable support-area lunch.

(8) Replace old C biscuits and whole wheat biscuits with Type I and II biscuits.

(9) add a packet of condiments for individual seasoning.

(10) Increase issue of chewing gum and peanuts.

(11) Rearrange Menu #5 so that chocolate bars and cocoa are served at different meals.

(12) Increase the proportion of sweet chocolate and reduce the issue of D bars and fruit bars.

(13) Add acceptable desserts to all menus.

ACTION:

Recommendations were followed and appropriate specific changes were made. The changed rations did reach the field in moderate quantities and the new C and 10-in-1 were being used eagerly by troops in the Pacific during the spring of 1945.

Project No. 30, 22 November 1944 - First Supplementary Report - Numerical Requirements for Statistically Valid Results in Field Test of Acceptability of Rations.

RECOMMENDATIONS:

The information contained in this report be made available to agencies engaged in ration tests.

ACTION:

Recommendations followed.

Report on Nutrition Survey in Pacific Theater of Operations, [illegible] August 194[illegible].

RECOMMENDATIONS:

No recommendations.

ACTION:

No action.

Informal Report of Observer, 17 November 1945.

RECOMMENDATIONS:

No recommendations.

ACTION:

No action

Project No. T-10, 12 June 1945 - The Design and Fit of Army Shoes.

RECOMMENDATIONS:

a. That a thorough study of foot disabilities resulting from misfitted shoes be undertaken.

b. That anthropometric measurements of soldiers feet be secured to provide a basis for the design and fitting of Army shoes.

c. That certain recommended changes in the structural characteristics of Army shoes be given consideration.

ACTION:

Further studies approved.

Project No. T-8, 6 March 1945 - Test of Harness, Man, M-1944, Type 1, QMC Project No. 257-43.

RECOMMENDATIONS:

That Harness, Apron Type, Double Trace, Type 1, be regarded not only as an adequate substitute for, but as physiologically preferable to, Harness, Man, M-1944, Type 1.

b. That consideration be given to measures for reducing pressure on the shoulder.

c. That the traces be a minimum of 7 feet long if they are to be provided as an integral part of the harness.

ACTION:

Negative action.

Project No. T-1, 11 April 1945 - Test of Suspenders, Pack, Field, Cargo and Combat (Support of the Pack, Field, M-1944, By Means of Suspenders which Incorporate a Strap Traversing the Chest).

RECOMMENDATIONS:

a. That the Modified Suspender described in Appendix I be manufactured in sufficient numbers, and be subjected to field tests by interested agencies.

ACTION: Disapproved by Infantry Board.

Project No. 5-1, 27 November 1942 - Adequate Head Room in Tanks.

RECOMMENDATIONS:

a. That these basic data be passed on to the Division of Tank Design, and Ordnance Department, with the recommendations that proper seat heights be provided in all future models.

b. That tank manufacturers be requested through proper channels to provide adequate clearance for men in the seats of new tanks now in production.

c. That the degree of elevation and lowering of the seats be related to the known facts about the sitting heights of men here included.

d. That tank seat design be facilitated by excluding from all future tank crews the upper and lower 5% of men. The resultant acceptable range of sitting heights, then becomes 34" to 38¼". The exclusion of 10% of men results in diminishing the requirement for seat vertical adjustability at either the high or low position of 50%.

e. Recommend that the Division of Tank Design, Ordnance Department, and the Armored Force Medical Research Laboratory collaborate in the design of proper seats to replace those which do not permit adequate headroom in existing tanks. It is apparent that such an alteration cannot readily be made in the field and the practicability of making a substitute seat should be seriously considered.

ACTION:

Recommendations followed. Seats designed and installed.

Project No. 5-8, 20 January 1943 - Effect of Exposure to Tank Noise Upon Hearing Acuity of Tank Crews.

RECOMMENDATIONS:

No recommendations made.

ACTION:

None

Project No. 5-12, 5 March 1943 - Seating Designing and Placing in Relation to Fatigue. Seat Design for M4 Tanks.

RECOMMENDATIONS:

a. Driver and assistant driver.

1. Vertical adjustment. A total excursion of 13" with a major shift of 10" from the up to the down position and with further independent adjustment of height in four (4) one-inch increments, as described in Appendix A and Figure 1.

2. Horizontal adjustment. Fore and aft adjustment, as in the present seats.

(3) Seat shape. Bucket-type padded seat, conforming in general to the design shown in Figure E.

(4) Back. Easily removable.

(5) Floor mounting. Provide for the easy removal without special tools of the assistant driver's seat from its floor mounting, in order to afford quick access to the escape hatch.

b. Gunner:

(1) Vertical adjustment. Retain the present range of vertical adjustment.

(2) Back. Provide a removable, single-column back rest similar to the back on a stenographer's chair.

c. Commander:

(1) Vertical adjustment. Provide vertical adjustment in the lower seat through four (4) one-inch increments, the upper seat to remain, as now, in a fixed position.

(2) Shape and size. Provide seats in the shape of a reversed D, with the broad dimension at the free end, (as in M7 tank) and as large as possible consistent with spatial limitations and with the necessity for folding out of the way when not in use.

(3) Back rest. Provide a back rest or pad to prevent direct contact with metal.

(4) Step formed when upper seat is folded. Make this as narrow as possible and round the corners to eliminate protrusion which strikes the commander's chest when he is using the periscope in certain positions.

d. Loader:

(1) Vertical adjustment. Provide vertical adjustment through four (4) one-inch increments.

(2) Shape and size. The same design requirements as outlined above for the commander's seat.

(3) Back rest. Provide a back rest or pad to prevent direct contact with metal.

e. General Specifications:

(1) Sturdiness. Seats and adjusting mechanism to be sturdily constructed and free from excessive vertical or horizontal play.

(2) Materials for seat and back padding. To be of maximum resilience and minimum thermal conductivity and non-inflammable.

(3) Painting. In the specifications to the first supplier include proper requirements with respect to painting that will insure free and smooth movement of the adjusting elements and permit only touch-up painting thereafter.

ACTION:

Acted upon favorably.

<u>Project No. 5-12 (Second Partial Report) 17 February 1945</u>, Seating Designing and Placing in Relation to Fatigue. Seats For Truck (4 x 4) ¼ Ton (Peep)

RECOMMENDATIONS:

a. That all seat cushions for Truck, ¼ Ton be two (2") inches of sponge rubber or equivalent.

b. That backs of driver and front passenger seats be of shape and size shown in Figure A, and have a minimum of one and one quarter (1¼") inch sponge rubber or equivalent and be designed to provide anchorage as nearly equivalent to that of driver's seat as is possible within suitable space limitations.

c. That padding be covered with water-proof covering of otherwise suitable characteristics.

ACTION:

No action taken at present.

<u>Project No. 5-12, 17 October 1945</u> - Seating Designing and Placing in Relation to Fatigue. Seat Cushions for Truck (4 x 4) ¼ Ton (Peep).

RECOMMENDATIONS:

a. That action be taken to improve ¼ ton truck (peep) seats to provide increased riding comfort, reduce fatigue and guard against low back injury.

b. That seat cushions of the type under discussion be considered in development of seats to meet requirements of Recommendation "a" above.

c. That other requirements listed in Armored Medical Research Laboratory's second partial report be considered in development of adequate seats for ¼ ton truck.

ACTION:

No action at present time.

<u>Project No. 9, 1 February 1942</u> - Anthropometric Measurements.

RECOMMENDATIONS:

a. This data be supplied to all agencies responsible for the design of army material.

ACTION: Recommendation followed.

Project No. 9 (Partial Report) 20 October 1945 - Size Increase of Men Wearing Various Clothing Combinations - Anthropometric Measurements.

RECOMMENDATIONS:

None.

ACTION:

None.

Project No. 42, 29 August 1944 - Letter Report on Test of Pack, Field, Cargo; Pack, Field, Combat; and Suspenders, Pack, Field, Cargo and Combat.

RECOMMENDATIONS:

a. That consideration be given to designing the pack suspenders so that they cross in front of the chest before attaching to the cartridge belt. By this means it is possible that the pack might be secured higher on the back, its sensible weight diminished, and the objectionable upward pull on the cartridge belt in front reduced.

b. That six (6) pack suspenders, designed to cross the chest, be fabricated and sent to the laboratory for test.

ACTION:

Recommendation "a" approved but recommendation "b" disapproved.

Project No. 24, 13 June 1945, (First Partial) - Study of Head Protection for Tank Crews.

RECOMMENDATIONS:

a. That with the change in chin strap support from outside to inside the latest version of the Quartermaster tank helmet be considered satisfactory for crash protection for tank crew use.

b. That standard M1 steel helmet worn over Quartermaster tank helmet be considered satisfactory only when worn outside the tank or with head out of open hatches and not satisfactory for use inside the tank.

c. That headrests of the type recommended in AMRL Project No. 6-1, 6-2, 6-3, 6-4, 6-6--Vision in Tanks --Eye Cups, Head Rests, and Head Clearances, dated 6 September 1944, be procured and installed on periscopes in tanks for use with the Quartermaster tank helmet.

d. That Ordnance development of Armored steel helmet to fit over Quartermaster tank helmet be continued to provide armored protection which will be satisfactory for use inside the tank in addition to use with head outside open hatches or outside tank.

e. That present Ordnance development of one piece steel helmet be completed for comparative evaluation.

ACTION:

Helmets made and tested but not used in field. (Impasse reached)

Project No. 24, 13 June 1945 - Study of Head Protection for Tank Crews. (first Partial)

RECOMMENDATIONS:

a. That with the change in chin strap support from outside to inside, the latest version of the Quartermaster tank helmet be considered satisfactory for crash protection for tank crew use.

b. That standard M1 steel helmet worn outside the tank or with head out of open hatches and not satisfactory for use inside the tank.

c. That headrests of the type recommended by AMRL Project No. 6-1, 6-2, 6-3, 6-4, 6-6 - Vision in Tanks - Eye Cups, Head Rests, and Head Clearances, dated 6 September 1944, be procured and installed on periscopes in tanks for use with the Quartermaster tank helmet.

d. That Ordnance development of Armored steel helmet to fit over Quartermaster tank helmets be continued to provide armor protection which will be satisfactory for use inside the tank in addition to use with head outside open hatches or outside tanks

e. That present Ordnance development of one piece steel helmet be completed for comparative evaluation.

ACTION:

These tests and their results have been utilized in the development of new tanks.

Project No. T-13, 4 December 1945 - Survey of Foot Measurements and the Proper Fit of Army Shoes, Study of Factors Bearing on the Establishment of Size Tariffs, on Size Designations, and on Shoe Fitting. (First Partial)

RECOMMENDATIONS:

None.

ACTION:

None.

Project No. T-13, 4 December 1945 - Survey of Foot Measurements and the Proper Fit of Army Shoes, Study of Sweating of the Feet of Marching Troops. (Second Partial)

RECOMMENDATIONS:

None.

ACTION:

None.

VENTILATION

Project No. 3-12, 20 December 1942 - Determination of the Carbon Monoxide Hazard from Auxiliary Generators in Tanks.

RECOMMENDATIONS:

a. The exhaust pipe from the auxiliary generator should be extended outside the rear wall of the engine compartment and be terminated at a point free from obstruction so that the exhaust is not deflected toward the air intake or exit openings in the engine compartment. The best location is believed to be near the bottom and to the side of the rear wall.

b. When a main exhaust deflector plate is provided, the auxiliary exhaust should be located below it and approximately ten (10) inches from the rear wall of the engine compartment.

c. All connections from the auxiliary generator engine to the exhaust pipe and other joints should be properly gasketed and maintained to prevent direct leakage into the fighting compartment.

d. Whenever possible hatches should be opened when the auxiliary generator is being operated with the tank engine not running.

ACTION:

Recommended changes were accomplished.

Project No. 3-12, 2 April 1943 - Determination of the Carbon Monoxide Hazard from Auxiliary Generators in Tanks.

RECOMMENDATIONS:

a. Extend the exhaust pipe from the auxiliary generator in the [illegible], M5A1, and M7 tanks so as to discharge beyond the rear wall of the engine compartment, in accordance with the recommendations of the report dated December 20, 1942.

b. Construction and maintenance of the exhaust line should be adequate to prevent direct leakage of exhaust gases into the fighting compartment.

c. Whenever possible, the hatches should be open during operation of the auxiliary generator with the tank motor not running.

ACTION:

Recommendations followed.

Project No. 3-12, April 2, 1943 -- Determination of the Carbon Monoxide Hazard from Auxiliary Generators in Tanks, (Supplementary Report).

RECOMMENDATIONS:

a. M4A4. The exhaust line from the auxiliary generator should be extended so as to discharge beyond the rear wall of the engine compartment, in accordance with the recommendations of the report dated December 20, 1942.

b. M5A1 and M7. In accordance with safe practice, consideration should be given to the extension of the exhaust pipes from the auxiliary generators in these tanks in connection with future changes in design.

c. Construction and maintenance of the exhaust line should be adequate to prevent direct leakage of exhaust gases into the fighting compartment.

d. Whenever possible, the hatches should be open during operation of the auxiliary generator with the tank motor not running.

ACTION:

As far as can be ascertained, recommended changes have been accomplished.

Project No. 3-2, 10 February 1943 - Report on Gun Fume Hazard from 37 mm Gun in M5 Light Tank.

RECOMMENDATIONS:

a. So long as the basic ventilation in the M5 light tanks is not changed, further consideration of the gun fume problem is unnecessary.

b. This tank should not be fired with the tank engine dead unless the turret hatch is opened.

ACTION:

So far as it is possible to measure results of these recommendations, basic ventilation characteristics remain unchanged and wherever possible the tank engine was operating during firing operations.

Project No. 3-2, 26 April 1943 - Determination of the Characteristics and Effects upon the Crew of Gun Fumes from Firing of the Weapons in Tanks of the M5 Series.

RECOMMENDATIONS:

a. Present ventilation of the M5A1 be considered adequate for control of gun fumes.

b. This tank should not be fired with the tank engine dead and the hatches closed.

ACTION:

Same as above.

Project No. 3-1, 3-5, 22 July 1943 - Determination of the Characteristics and Effects Upon the Crew of Gun Fumes from Firing of the Weapons in Tanks of the M4 Series and Correlation of Basic Ventilation Data with Gun Fume Studies and Development of an Effective Design of Improvement for the Control of Gun Fumes in the M4 Tanks.

RECOMMENDATIONS:

a. That the advantages of positive-pressure ventilation from the standpoint of control of gun fumes be considered with other advantages in making a final decision with reference to gas-proofing tanks.

b. That this report be distributed to agencies concerned with the development of the gas-proof tank.

ACTION:

Subsequent to this report, Office, Chief of Ordnance, Detroit, modified medium tank, T23 for positive-pressure ventilation in conjunction with necessary equipment for gas proofing. This vehicle was used in tests conducted at Fort Knox, Kentucky and Camp Polk, Louisiana.

Project No. 3-1, 3-5, 15 February 1943 - Control of Gun Fumes in M4 Series Medium Tanks.

RECOMMENDATIONS:

a. Install a turret exhaust system in all tanks of the M4 series to be shipped overseas.

b. Provide kits for the field installation of such an exhaust system in all M4 tanks now overseas.

c. The capacity of the exhaust system to be not less than 150 cubic feet per minute with the inlet located over the breech at recoil position.

ACTION:

At the close of hostilities in Europe all M4 medium tanks had installed a turret exhaust system similar to the requirements set up in this report.

Project No. 3-4, 3-6, 26 April 1943 - Determination of Basic Ventilation Characteristics of Tanks of the M4 and M5 Series.

RECOMMENDATIONS:

That this report be distributed to interested agencies.

ACTION:

This report dealt with the control of gun fumes, removal of heat, dust control and crew compartment heating of armored vehicles. The information distributed to Office, Chief of Ordnance, Manufacturers and other interested agencies was utilized as a guide for subsequent tank design.

Project No. 3-9, 24 December 1942 - Ventilation Requirements for Gas-Proofing the M5 Tanks.

RECOMMENDATIONS:

a. That Ordnance Department be requested to prepare an M5 tank with a tight bulkhead and with minimum leakage around turret ring and 37 mm gun mount this tank to be shipped to Fort Knox for further tests by the Armored Force Medical Research Laboratory.

b. If the leakage is found to be reduced sufficiently, a positive-pressure system of ventilation and gas canister will then be installed for actual field tests.

ACTION:

No action.

Project No. 3-9, 1 March 1943 - Ventilation Requirements for Gas-Proofing Tanks of the M4 Series.

RECOMMENDATIONS:

That this report be transmitted to the agencies concerned with the gas-proofing of vehicles.

ACTION:

This report reached Chemical Warfare Service Development Laboratory and the information obtained as utilized by AMRL to fabricate and test the gas-proof vehicle at Fort Knox, Kentucky.

Project No. 3-9 (Second Partial) 23 June 1943 - Determination of Ventilation Requirements for Gas-Proofing Tanks of the M4 Series.

RECOMMENDATIONS:

a. That further development of the positive-pressure system of ventilation in tanks of the M4 series be carried out by the Tank Automotive Center, Ordnance Department, with immediate consideration being given to the M4A2 model so that the necessary changes can be made rapidly in the event the gas-protection of tanks is needed.

b. That, in this development, full consideration be given from the start to the entire problem, namely, the question of adequate power, re-location of radiators and air cleaners, storage arrangements to accommodate the additional equipment, etc., as well as the problem of sealing, ventilation rate and other aspects of design of the positive-pressure system.

c. That a pilot model of a modified M4A2 tank be constructed to provide a system of positive -pressure ventilation and canister for gas-protection and incorporating all other necessary changes and that this tank be subjected to further field tests with respect to its mechanical operation, accessibility of parts for maintenance as well as gas-protection.

c. That the Chemical Warfare Service, in cooperation with Ordnance, develop gas canisters of the required efficiency, life, size and other characteristics for use with positive-pressure ventilation in the [illegible] tanks.

ACTION:

Recommendations followed.

Project No. 3-13, 8 April 1943 - Determination of the Characteristics and Effects Upon the Crew of Gun Fumes from Firing of the Weapons on the M7 Tank.

RECOMMENDATIONS:

a. That the present turret ventilation be modified to provide increased exhaust ventilation and the exhaust intake be relocated for more efficient removal of fumes from the 75mm gun.

b. That the turret machine gun be remounted in such a manner as to prevent the entry of fumes from the gun muzzle into the turret.

ACTION:

This vehicle was manufactured only under limited procurement [illegible] modifications herein made in the new vehicles manufactured subsequent to this report.

Project No. 3-15, 29 April 1943 - Determination of the Characteristics and Effects Upon the Crew of Gun Fumes from Firing of the Weapons in the [illegible] Tank.

RECOMMENDATIONS:

a. 105mm Howitzer.

(1) That independent exhaust ventilation be provided in the turret for the control of fumes from the 105 mm howitzer.

(2) That the turret machine gun be mounted in such a manner as to prevent entry of fumes from the gun muzzle into the turret.

ACTION:

a. Independent turret exhaust ventilation was provided in this vehicle at a later date.

b. Information on modification of the turret machine gun is unknown.

Project No. 17, 7 March 1944 - Protection of Personnel in Tanks Against Toxic Agent.

RECOMMENDATIONS:

In view of the present active development of a system of individual gas-protection of U. S. Tanks, similar in principle to the Canadian system, by Ordnance and CWS, no specific recommendations are made. The present report is for information.

ACTION:

Active field trials of this system of gas protection were in progress in the Pacific Theater at the cessation of hostilities.

Project No. 28, 11 May 1944 - Investigation of the Hazard from Exhaust Gases in Tanks that are in Tow.

RECOMMENDATIONS:

a. That Ordnance develop a suitable device to eliminate the exhaust fume hazard from M32B1 recovery vehicle, and that this be submitted for test.

b. That all crews of recovery vehicles and tanks be informed of the potential danger of carbon monoxide poisoning in towed tanks and that instructions be issued to keep men out of tanks in tow so far as possible. This applies particularly to the use of the M4A1 tank and M32B1 recovery vehicle with bar, tow, as connector and that frequent periodic check of the occupants of the towed vehicle be made

ACTION:

An M5 tank as recommended in this report was not received at this Laboratory for test. Subsequent tests on gas-proofing on armored vehicles were conducted on an M4 Medium Tank.

Project No. T-14, 22 October 1945 - Discussion of Ventilation Requirements of Armored Vehicles.

RECOMMENDATIONS:

a. That, in future tank design and development, basic requirements for design and operation of the crew compartment ventilation system be considered with other fundamental requirements in the initial plans.

b. That crew compartment ventilation operate independently of the main tank engine and be capable of continuous operation for several hours.

c. That, in the design of the crew compartment ventilation system, provisions be made for:

(1) Control of gun fumes at the maximum rate of fire to be encountered in combat.

(2) Maintenance of the atmosphere in closed tanks within tolerable limits of heat and humidity during intense combat of long duration in tropical climates.

(3) Maintenance of reasonable crew comfort in tank operation at low temperature.

(4) Elimination of the dust nuisance in closed tanks.

ACTION:

No action.

Project No. T-7, 19 April 1945 - Test of Carbon Monoxide Hazard From [illegible] in Light Tank, M24.

RECOMMENDATION:

Redesign exhaust tail pipes to eliminate contamination of air entering fighting compartment by engine exhaust fumes.

ACTION:

This design was in mock-up stage for immediate production at the close of hostilities.

Project No. 34, 1 May 1944 - Evaluation of the Gun Fume Hazard in the LVT A-1.

RECOMMENDATION:

That an exhaust fan of approximately 200 cfm capacity be installed in the rear of the turret as shown in Figure 2.

ACTION:

Recommendation set forth in this report was unheeded by responsible design personnel. This vehicle reached the laboratory at such a late date in its manufacturing procurement program that contracts for continued production had been completed. This was a Navy design, Army operated vehicle.

Project No. 41 (First Partial Report) 19 July 1944 - Control of Gun Fume Hazard.

RECOMMENDATIONS:

a. That a system of positive-pressure ventilation having the characteristics listed below be considered adequate for control of the gun fume hazard in the T 25 and T 26E1 tanks:

Capacity - not less than 1000 cfm.

Static pressure (all hatches closed, 90 mm gun breech open) not less than 0.7 inches, water gage.

ACTION:

No action.

Project No. 45, 26 February 1945 - Physiological and Operational Characteristics of T26E3 Tank.

RECOMMENDATIONS:

That the following essential changes and improvements be initiated immediately (3) change hull design to permit field installation of 1000 cfm fan and provide adapter to support present fan for interim use.

ACTION: On next page.

CTION:

After one year of exchange of correspondence through channels, Office, Chief of Ordnance-Detroit made a limited effort to provide a solution to this hazard. A compromise was arranged in the meantime which partially solved the problem. Excellent cooperation was obtained in informing tank personnel of the hazard.

FIRE AND FLAME PROTECTION

Project No. 10, 17 June 1943 - Test of Truck, 3/4 Ton, Improved Insulated Ambulance

RECOMMENDATIONS:

a. That the use of improved wall insulation alone, as exemplified by subject vehicle, not be considered adequate for temperature control within ambulances.

b. That, if reduction of temperature below the outside level is to be achieved, mechanical refrigeration plus adequate wall insulation be provided. (See Project 2-29, 15 May 1943).

c. If mechanical refrigeration cannot be employed, that wall insulation plus forced ventilation be provided.

ACTION:

No further development work or procurement of insulated ambulance was known to this Laboratory.

Project No. 14, 13 November 1943 - Methods of Protection Against Flash Burns.

RECOMMENDATIONS:

a. That the protective cream described in Appendix F be procured for immediate issue to tank crews in combat areas.

b. That a 5-day supply (10-4½)oz. cans be carried as part of regular stowage and that issue be established to maintain this supply. If used daily 2/cans/crew/day are required.

c. That instructions be issued regarding use of the protective cream.

ACTION:

Recommendations followed. Creams were shipped but never used so were stored overseas.

Project No. 14, 20 July 1944 - Supplemental Report on Methods of Protection Against Flash Burns. Subject - Time-Temperature Relationships Which Produce Hot Air Burns of Human Skin.

RECOMMENDATIONS:

Since the time required for first and second-degree burns within the relatively low temperature range tested is quite short in comparison with observed tank evacuation times, continued vigilance must be maintained to protect tank crews by providing adequate fire-fighting equipment, by insisting on use of proper clothing, protective cream, and by ensuring adequate, easily-opened exits.

ACTIONS:

No action.

Project No. 35, 13 September 1944 - Determination of the Optimum Method for Protection of Tank Crews Against Chemical Warfare Agents.

RECOMMENDATIONS:

a. That the combat mask and impregnated clothing be considered the most practical method now available for field issue.

b. The development and improvement of combat mask be pursued along following lines:

(1) Reduce the thickness of the attachment tabs of the head harness to the facepiece in order to eliminate localized areas of pressure under the crash helmet.

(2) Rearrange the head harness straps to avoid interference with the newly developed head phones (HS-16) (U) for tank crews.

(3) Redesign the eyepieces of the mask to provide for a greater field vision, give binocular vision at close range, and permit proper use of newer fire control equipment. Reduction of eye relief to a minimum can secure these aims.

(4) Relocate the canister in a position interfering least with other tank equipment and the activities of tank crews.

(5) Reduce canister resistance to the minimum compatible with adequate protection.

c. Further development of collective protection by positive-pressure ventilation be pursued.

d. Improve the impregnated clothing assembly: (1) make hood of lighter material and of sufficient size to fit over crash helmet, (2) wristlets of gloves should reach midway to the elbow, (3) fasten rear and front of jacket to trousers.

e. Protective ointment, M5, be considered an inadequate substitute for the impregnated hood and glove wristlets until further tests demonstrate its protective value after prolonged use in closed tanks operating in hot climates.

f. Coordinate all development of protective equipment for use by Armored personnel with the Armored Center.

ACTION:

The recommendations set forth in this project were currently active at the close of hostilities with Japan.

Project No. T-4, 8 December 1944 - Report on Test of Injuries and Burns from Rocket Launchers.

RECOMMENDATIONS:

a. When firing the rocket launcher models M9 and M9A1, no protection for the exposed skin is necessary unless the temperature is below 32°F. Protection for the eyes is always desirable.

b. When using the rocket launcher model M1A1, protection should always be provided for the exposed skin of the hands, face and neck. Protection for the eyes is most important.

c. Protection may consist of goggles, glasses, or shields for the eyes and a cloth screen for the exposed skin of the face and neck. The cloth screen should extend laterally and downward sufficiently to ensure adequate shielding of the ears and lower neck. Gloves should always be worn.

d. Non-inflammability of protective devices is desirable.

e. All precautions should be rigorously observed when firing at temperatures below freezing.

f. Several face masks consisting of goggles or plastic eye shields fitted with protective cloth screens for the face and neck, now under development by OQMG may be considered adequate.

ACTION:

Masks were made and sent to theaters of operation.

Project No. T-5, 17 July 1945 (First Partial) Physiologic Effects of Wearing Flameproofed Clothing in Hot Environments. Test of Flameproofed Clothing.

RECOMMENDATIONS:

a. That the material of this report be distributed to agencies concerned in the development of formulas and ultimate use of clothing designed to protect against fire and chemical warefare agents.

b. That these agencies continue to consider, along the lines developed in this report, not only the protective qualities of such clothing but all of the new problems which arise in the ultimate wearer.

ACTION:

Became basis of additional work on flame protective clothing.

Project No. T-5, 21 July 1945 (Second Partial) Effects of Wearing Flameproofed Clothing in Hot Environments.

RECOMMENDATIONS:

a. That flameproofed "X" clothing be considered unsatisfactory for issue to troops because the flame resistance of flameproofed "X" garments was inferior to that of flameproofed "L" garments, both before and after wear.

b. That this report be considered in conjunction with the other partial reports from this laboratory.

ACTION:

Issue of this clothing was discontinued and development of new clothing instituted.

Project No. T-5, Third Partial, 31 July 1945 - Effects of Wearing Flameproofed Clothing in Hot Environments.

RECOMMENDATIONS:

a. That both antimony trioxide or laundered foam-process impregnated herringbone twill garment be evaluated from the standpoint of retention of adequate flameproof qualities are fond to be satisfactory.

ACTION:

Recommendations followed in clothing found to offer inadequate protection.

Project No. T-5, Fourth Partial, 22 September 1945 - Test of Physiological Heat Load of Flameproofed Clothing.

RECOMMENDATIONS:

That if field tests show the garment to have satisfactory durability, "[illegible]" treated uniforms be considered suitable for issue.

ACTION:

These recommendations now being followed by AGF Boards.

Project No. 27, 13 March 1944 - Fire Resisting Compounds for Clothing.

RECOMMENDATIONS:

a. That field impregnation of fatigue uniforms with "Fire Retardant CW" be considered an effective temporary measure for stopping fires.

b. "Fire Retardant CW" or other agent of equally desirable characteristics be issued to the following men in the combat zones of all theaters, basis of issue to be 25 pounds per tank company or equivalant.

(1) Tank and other vehicle crews.

(2) Gasoline and ammunition handlers (1st echelon).

(3) Personnel handling or using incendiary agents including flame throwers.

(4) Other personnel designated by unit commanders because of exposure to fire hazards.

c. Instructions be issued for application of the retardent. A proposed draft is attached.

d. Development of more effective and permanent methods of fire-proofing clothing be continued.

ACTION:

No action.

PROJECT No. 6 - VISION IN TANKS - Determination of Visual Requirements for Various Tasks in Armored Vehicles.

RECOMMENDATIONS:

1. That the Armored Force carry out acceptance tests on pilot models of sights issued for armored vehicles.

ACTION: Recommendation approved and followed.

2. That a better corrected optical system be substituted in the M50 series sight production at the earliest possible time, securing adequate flatness of field and resolving power.

ACTION: See Summary

3. Assembly procedures (in M50 sight series) be modified to insure maximum effectiveness, especially a compromise focal setting.

ACTION: See Summary

4. That the bore-sight mark on reticule on low velocity guns be raised as much as possible in order to bring a greater portion of the reticule into the useful field.

ACTION: See Summary

5. That every effort be made to make the reticule markings as fine as compatible with good visibility and that the refractive border around the lines be held to a minimum.

ACTION: See Summary

6. That the project of half-wave coating of the interior optical surfaces of telescopes be expedited.

ACTION: See Summary

7. That an adequately rugged telescopic sight mount be developed that would keep the sight in adjustment during cross-country operations.

ACTION: See Summary

8. That mechanical linkage and mounting of the periscopic sight be revised to secure adequate precision and ruggedness.

ACTION: Recommendation followed, after long and serious delay.

9. That two dual periscopic sights for which drawings were submitted be developed and sent to Fort Knox, Ky for test.

ACTION: Recommendation followed after long delay.

10. That three telescopic sights for which drawings were submitted be developed and sent to Fort Knox, Ky for test.

ACTION: Recommendation followed after some delay.

11. That, in turret design, spatial arrangement be such that (a) Ready access to and effective joint use of both periscopic and telescopic sights is assured.

ACTION: See Summary.

(b) That co-axial telescope be used in a single seat position form -11° to +10° elevation without tiring the gunner.

ACTION: None.

(c) That no interference occurs to prevent the use of both sights by men of either eye dominance.

ACTION: None.

(d) That controls be so located that full movements and natural coordination are possible for at least the commonly occuring positions of the gunner.

ACTION: See Summary.

12. That the mounting of the coaxial telescope be of such ruggedness that loss of alignment will not be greater than ¼ mil under loading tests in excess of common use requirements.

ACTION: Recommendation in the process of being followed.

13. That bore-sighting adjustments be:(a) Smooth and without detent. ACTION: Recommendation followed on a few instruments. (b) Independent in elevation and azimuth. ACTION: Recommendation followed. (c) Capable of being locked without disturbing the allignment. ACTION: Attempts are still being made to satisfy this requirement.

14. That, in new turret designs, the opening in the top armor for the periscope be increased to permit adequate precision and rigidity in mounting the periscope. ACTION: Recommendation followed.

15. That clearance in the mounting of the periscope be increased to avoid binding by grit, etc.

ACTION: See Summary.

16. That effective lever lengths of the periscope linkage be increased to the point where common machine practice will insure an accuracy of allignment of within ¼ mil.

ACTION: A compromise accuracy of about 1/3 mil was obtained.

17. That a lateral offset sight be considered for use in all turrets that mount guns in excess of 76 mm.

ACTION: None.

18. That, for the improved method of fire control, a combination of built-in rangefinder and coaxial cannon of proper range and trajectory with dual range scale sight be considered.

ACTION: None.

19. That Perkin and Elmer sight replace the M70 series without obsolescence.

ACTION: None.

20. That the procedure of adjusting M70 Series sights be modified to secure freedom from parallax and to insure use of positive eye accomodation over the field occupied by the reticule markings.

ACTION: Recommendation followed in about 60% of cases.

21. That new sight designs be chosen with respect to their performance at the longest range positions in the field.

ACTION: See Summary.

22. That production tests be instituted to insure proper setting of lenses for adequate performance at the longest range positions.

ACTION: See Summary.

23. That the T106E1 (3 power telescope in large tube) be employed with low velocity weapons, but a 3X sight of the periscopic offset type requiring less eye travel be developed.

ACTION: Recommendation followed - 3X periscopic offset sight (T-19) was developed after long delay.

24. That sight T106E1 be employed as a secondary control unit in conjunction with higher power sights for high velocity weapons.

ACTION: None.

25. Employment of M71 series (5X) sights be restricted to high velocity weapons requiring a higher power sight than now available and not requiring a large field of good definition.

ACTION: See Summary.

26. Data given (appendix of report, Project #6-1, 6-[illegible], 6-3, 6-4, 6-6, file [illegible].74-3 SPMEA - 6 Sept 19[illegible], be used for all new design of eyepieces and headrests.

ACTION: Compromise eyepieces and headrests of considerable improvement over the old type have been developed.

27. Revision in production should be made on wide field telescopes.

ACTION: None.

28. Head-rests should be modified on T-8, M-10, T-9, E1, and M-4 periscopes in order to reconcile them with helmets.

ACTION: Recommendation followed on T-9, E1, T-8, M-10.

29. Standardization limiting dimentions for head rests be adopted to serve as a basis for design.

ACTION: See followed.

30. That 3 pairs of periscopic binoculars of the characteristics specified in drawing be developed and sent to Fort Knox, Ky for test.

ACTION: After an 18 month delay, two of these instruments were sent to Fort Knox. Naturally, these instruments were not developed in time to see action in battle. As of this date (Dec 1945) only two pilot models of this instrument have been made, to our knowledge.

31. That suggested modification, or one of similar properties, for I. P. D. and diopter settings be applied to binoculars for use by ground troops engaged in night operations.

ACTION: None as yet.

32. That, for future procurement I. P. D. and diopter setting devices be designed into production binoculars for ground troop use.

ACTION: None as yet.

33. That vision blocks be employed for driver vision instead of periscope.

ACTION: None.

34. Three such units be installed providing for greater than 180° over-lapping vision.

ACTION: None.

35. That a spring device similar to that described in appendix of report (6-2, 5th partial report, 24 Aug 1944) be developed as a field fix on present vehicle to permit driver to rotate his periscope on its axis by head pressure alone.

ACTION: None.

Project No. 7-6, 29 March 1945 - Test of Glasses, Sun.

RECOMMENDATIONS:

a. That Glasses, Sun, M-1944, and Glasses, Sun, F-1 AAF 3304 be considered satisfactory for protection against excessive glare where dust is not a problem.

b. That clip-on type sun glasses be supplied with essentially neutral density lens with transmission of 8% - 18% and otherwise conforming to optical characteristic JQD No. 594, 18 October 1944, except that arms shall be made sturdier and arranged to clip together better.

c. That strong, light, metal, rectangular, dust-proof case with inside padding be supplied as carrying case for Glasses, Sun, M-1944 and F-1 AAF 3304.

d. That strong, light, metal, circular, or square dust-proof case with inside padding be supplied as carrying case for clip-on type sun glasses.

e. That lens cloths be included in carrying case c and d above.

f. That research be continued by QM to reduce back reflection and provide more scratch resistant lens and that changes be made as improvements are found.

ACTION:

In general recommendations followed and work is still in progress.

Project No. 7-1, 4 August 1943 - Determination of the Lighting Requirements for Various Tasks of Tank Crews.

RECOMMENDATIONS:

That this report be distributed to agencies concerned with design of interior lighting systems for tanks and other armored vehicles.

NOTE: This report provides basic information on the principles of design of interior lighting systems for tanks. It is supplemental to the report on Project 7 - Night Vision from Tanks, Sub-Project No. 7-2 - Determination of Intensity, Distribution and Type of Illumination in Tanks Least Disturbing to Dark Adaptation. Sub-Project No. 7-3 - Investigation of Methods of Improving Night Vision in Tank Crews by the Use of Eye Appliances, entitled Report on Interior Lighting of M4 Tanks, 22 February 1943, and is applicable to the problem of interior lighting of all armored vehicles which are intended for use at night.

ACTION:

Recommendations followed.

Project No. 7-2, 7-3, 5 December 1942 - The Use of Red Light for Maintaining Dark Adaptation in Tanks (Partial Report).

RECOMMENDATIONS:

a. That ten (10) M4 medium tanks be equipped with red filters and these tanks be used in night problems by a field unit to determine the adequacy of lighting

under a variety of conditions.

b. That other changes (Appendix V) be made in these tanks to secure the maximum improvement possible.

c. That night vision testing of the tank crews to be used for night operations be carried out.

d. That instruction in the proper use of the eyes at night be given these men prior to the night operations.

ACTION:

Recommendations followed and installed in tanks.

Project No. 7-2, 7-3, 25 February 1943 - Interior Lighting of M4 Tanks.

RECOMMENDATIONS:

a. That the dual lighting and controls described in the appendix be installed in M4 tanks, - three fixtures in the turret, two in the bow and one in the starboard sponson.

b. That instructions regarding the proper use of red light for preserving dark adaptation be given to all tank crew members and that night training with the lights be made a part of the advanced training program.

c. That the following additional aids to night vision be incorporated in the M4 tank: (1) Lettering that must be read at low light intensities should be block type, white on black letter at least one inch in height, line width ¼ inch. (2) All knobs, controls, etc. to be painted white. (3) Instrument panels be redesigned and relocated for better day and night use. (4) Maps for night use to be printed boldly black on white or tonal keyed. Maps with red printing are unsuited for use with red light unless tonal keyed. (See Appendix III).

d. That one-half of the regular complement of flashlights be fitted with red filter material.

e. That all light fixtures be installed "spring-loaded" to protect against failure when the tank is hit.

f. That the reflectors of fixtures be carefully painted with a white, high re-reflecting paint such titanium oxide paint.

g. That all switches be capable of withstanding severe vibration.

h. That the trouble-light connections be retained adjacent to commander's light and on the instrument panel.

i. That auxiliary lighting for map and instrument panel reading after exposure to glare of the order 10,000 foot candles (sun on desert or snow) be provided by 32-candle power bulbs to be used in the emergency (trouble) light.

ACTION:

Recommendations followed.

Project No 7-6, 11 May 1944 - Establishment of Criteria and Methods for the Selection of Crews for Night Operations.

RECOMMENDATIONS:

a. That an organization with authority and personnel to select, train and educate men in the United States and overseas in the practical aspects of night-seeing be set up.

ACTION:

Never adopted.

Project No. 7-8, 1 May 1944 - Comparison and Evaluation of Field and Laboratory Methods of Measuring Night Visual Acuity.

RECOMMENDATIONS:

a. That the luminous plaque described in appendix be considered satisfactory as a night vision tester for selection of ground troops for night operations.

b. Recommendation for basis of issue and operating procedure for testing are incorporated in a final report now under review.

ACTION:

Not adopted.

Action on Project 6 - Vision in Tanks.

The inadequacy of the existing provisions for fire control and general vision on earlier tanks was well recognized, but the prevalent opinion at the time was that little improvement was possible. The physics section formulated concrete proposals for the development of adequate instruments and equipment to improve fire control in tanks (Project 6-2, 23 Jan 1943). In this summary report armored needs were analyzed and specific engineering proposals for both immediate remedial measures and longer term developments were made. The Armored Headquarters, Armored School and Armored Board cooperated in the proposal of new and wider field telescopes and more adequate telescopic mounts. These resulted in the development and production of the M70 series sight in time to see wide spread battle usage beginning with the Normandy Invasion. The longer term undertakings included the design and development of wide field telescopes and a dual periscopic sight (T8 or M10) for which design drawings were submitted at an early date. The development and implementation of these wide field telescopes proceeded according to plan, and the resulting M72 and M76 series telescopes were provided on the later tanks and tank destroyers in time for employment in the later phases of the Europeon and Pacific campaigns. However, the development of the dual power periscopic sight was long delayed, and although some six hundred (600) of these instruments were in the base depots in Europe, a very small percentage of these saw action. This may be due to a lack of front line publicity for the instruments.

The laboratory realized at an early date that adequate all-round provision for tank commanders was badly needed. As a result of frequent consultation between the Laboratory, Armored Board and Ordnance a compromise vision cupola was designed and developed in time to see wide usage in both Europe and the Pacific. (Armored Board, Project 446).

Of equal importance from the stand point of adequacy of fire control, were later developments that failed to find battle employment because of long delays in implementation. The periscopic binocular, for example, was proposed in Feb 1943 (Project 6-1, 6-6). The need for this instrument was obvious throughout the war and became acute in the close in or jungle warfare in the Pacific campaign. As of December 1945 only two (2) pilot models of the instrument have been seen, and these in the United States only. Among other developments suggested by the laboratory are the high powered scanning binoculars, the spectacle type binocular and an improved aiming circle for use by artillery. These developments have not, to our knowledge, proceeded past the discussion stage.

Fire control ideas by the physics section during the war were incorporated into the Army Ground Force Equipment Review Board report through the collaboration of the Armored Center, the Armored School and the Armored Board in the formulation of its summary. Efforts were also made by the laboratory in the evolution of tank design in order to secure adequate turret space and convenient arrangement of controls, leading to more efficient gunnery. Reports on the physiological characteristics of the T23, M24, T25E1, and T26E3 tanks led to modified designs of later tanks providing greater room for movement within the tank and much increased efficiency in tank maneuvers.

Project No. P-38, 1 May 1944 - The Military Characteristics and Design of Observation Telescope.

RECOMMENDATIONS:

That instruments of the three types for which military characteristics and preliminary layouts are furnished in the Appendices be constructed and submitted to field test.

ACTION:

No instruments have been constructed.

Project No. P-40, 30 May 1944 - Military Characteristics of Spectacle-Type Binoculars.

RECOMMENDATIONS:

a. That an experienced producer of binoculars be authorized to build two (2) pilot models of the six (6) power prismatic spectacle type binoculars in accordance with specifications in appendix A.

b. That the method of support be made a subject of experimental study upon completion of the model.

c. That two pilot models of a Galilean type, three (3) power spectacle binoculars be constructed in plastic optics by a manufacturer experienced in design and construction of plastic Galilean instruments, in accordance with Appendix B.

d. That the head support of this type be made a subject for further study upon completion of model.

e. That the development of both these types of spectacle binoculars be carried out by the manufacturer in close collaboration with the Physics Section of the Armored Medical Research Laboratory.

ACTION:

See the general statements on Project 6 - Vision in Tanks.

Project No. P-47, 7 September 1944 - Test of Telescopes T122 and T123.

RECOMMENDATIONS:

a. That the continuously variable power telescopic sight T122 be procured to whatever extent is practicable.

That it be employed on vehicles mounting high velocity guns in the following manner;

(1) In those vehicles for which the T8 and M10 sights are not available.

(2) As a reserve sight when the above needs are satisfied.

c. That the M76 and T106, 3 power wide field telescope be employed on vehicles mounting low velocity guns until such time as a practical mount can be developed which provides the (super) elevation required externally, thus obviating the necessity of a large reticle field.

d. That efforts be continued to develop a straight tube, lens erecting, telescope exhibiting better contrast, transmission and color correction. This will presumably arise from a compromise in which the number of components are reduced without sacrificing the advantages of astigmatic correction. If this can be accomplished more readily with selection of two specific powers instead of continuously variability, that approach should not be discouraged.

ACTION:

See general statements on Project 6 - Vision in Tanks.

Project No. P-48, 22 September 1944 - Report on Periscopic Sight T8 and Mount T105.

RECOMMENDATIONS:

a. Subject periscopic sight, T8, be considered adequate for production.

b. A new rheostat for controlling the illumination of the reflex reticle be substituted providing ranges of 100 and 400 ohms for day and night use, respectively.

c. The head-rest be modified in shape to accommodate proposed new crash helmet.

d. Mounting of the head-rest be modified to provide necessary eye depth adjustability.

e. Peripheral light be eliminated from the illumination of 6 power reticle.

f. Defects in construction and installation of pressure springs be eliminated.

g. Strict instructions be issued to insure complete installation of mount and linkage.

h. Improvement in eye cup design for 6 power sight be investigated but without delaying production.

ACTION:

See general statements on Project 6 - Vision in Tanks.

Project No. P-49, 15 October 1945 - Plan for Fire Control Research and Development.

RECOMMENDATIONS:

a. That research and development of fire control be predicated on a completely new evaluation of war agencies.

b. That possibilities of new agencies arising from new potentialities in energy storage and utilization be investigated.

c. That possibilities of new agencies arising from new methods of fire control be investigated, especially remote detection, location and guiding.

d. That employment of present agencies be re-examined in the light of new developments.

e. That basic research be pursued to evaluate man's capabilities in sense perceptions and intelligence.

f. That possibilities of special selection and training be investigated in order to establish the skill in sense perception and grade of intelligence available for fire control.

g. That research be continued to improve physical means for extending sharpening or amplifying man's sense perceptions, such as binoculars, sights, sonic amplifiers, etc.

h. That research be continued on physical means for supplementing men's senses, such as infra-red devices and radar.

i. That research be continued on physical means for performing the functions of man's senses, either eliminating him or removing him to a great distance -- such as photo cell actuation, television, etc.

j. That research be continued on mathematical and physical means of augmenting or eliminating the operations of man's intelligence.

k. That emphasis be removed from continued elaboration and perfection of fire control devices predicated on present agencies and employment, except for the purpose of demonstrating basic capabilities of techniques and principles.

l. That facilities, skills and means of special fabrication of fire control devices be subsidized and employed in basic research and development. This applies especially to optics.

m. That only after and on the basis of a thorough and objective revaluation of war agencies, the detailed elaboration of fire control devices for specific employment be undertaken.

ACTION:

Nothing has been done as of this date. Recommendations are being considered.

<u>Project No. 21 (First Partial Report) 24 May 1944</u> - Determination of the Sources, Magnitude and Costs of Gunnery Errors.

RECOMMENDATIONS:

a. That the data contained in the report be considered in decisions with respect to future use of the present stabilization equipment and in the development of tactical plans which involve firing on the move.

ACTION:

Not approved.

<u>Project No. 21 (Second Partial Report)</u> - Determination of the Sources, Magnitude and Costs of Gunnery Errors. 16 June 1944.

RECOMMENDATIONS:

a. That the data contained in this report be considered in decisions with respect to further use of the present stabilization equipment and in the development of tactical plans which involve firing on the move.

b. That in any further development of gun-stabilizing equipment for moving fire, provisions be made for horizontal as well as vertical stabilization and that the necessary degree of stabilization be determined in relation to size of targets to be engaged and maximum range of fire to be employed so that the reaction time of the gunner will have minimum influence upon the precision or frequency of fire from the moving tank.

c. That tests of any future gun-stabilizing equipment (apart from tests for determining mechanical reliability or problems of maintenance) be based upon quantitative measurements of precision of fire and rate of effective fire over the same courses against targets at various ranges out to the range of maximum employment, and that these be evaluated in relation to measurements of angular travel of the gun relative to the targets.

ACTION:

Not approved.

<u>Project No 37, NDRC, SOS-11, 18 September 1944</u> - Study of Errors in Field Artillery Practice.

RECOMMENDATIONS:

a. That every instrument employed in the conduct of Artillery fire be studied systematically with reference to its probable contribution to errors and improved instruments be designed to eliminate such sources of error.

b. That a critical job analysis be made of each major division of the operations involved in the conduct of Artillery fire, to provide more detailed information relative to the causes of error and to furnish the basis for development of methods of improvement.

c. That test facilities, including means for complete recording of all operations in the conduct of fire, be established and employed (1) for measuring the relative influence of errors from different sources upon the overall effectiveness of fire which can be expected from improved instruments or proposed changes in procedure.

ACTION:

Action formed a basis for next partial report.

Project No. 37 (Second Partial) 22 March 1945 - Study of Errors in Field Artillery Practice.

RECOMMENDATIONS:

That the proposed new flat dial type panoramic telescope described in Appendix II and the accompanying drawings (Figures 4 and 7) be constructed in sufficient numbers in pilot form for field acceptance tests, such tests to evaluate the relative certainty of reading deflection and setting off deflection shifts in actual service practice, as well as to determine the ruggedness, serviceability, etc., of the instrument.

ACTION:

A model was built in the Laboratory workshop and tested. See other Partial Report.

Project No 37 (Third Partial) 6 April 1945 - Study of Errors in Field Artillery Practice.

RECOMMENDATIONS:

a. Provide separate means for laying guns for elevation and angle of site on all artillery pieces which employ time fire.

b. Provide elevation and angle of site indicating instruments of direct-reading types, as outlined in Appendix II, wherein the entire angular value is obtained as a continuous number read from left to right and requiring minimum interpolation on the scale.

c. Improve gunner's quadrant, M1, as outlined in Appendix II.

d. In any program for future developments in artillery materiel, that consideration be given to maximum possible standardization of fire control equipment so as to reduce the number and variety of instruments for laying guns in elevation.

e. Provide leveling vials with the red lines permanently fused into the glass.

ACTION:

No known action.

Project No. 37 (Fourth Partial) 28 March 1945 - Study of Errors in Field Artillery Practice.

RECOMMENDATIONS:

That an in-telescope, direct reading aiming circle, of the type presented in Appendix I, be developed and sufficient pilot models be constructed for field test.

ACTION:

No known action.

Project No. 37 (Final Report) 13 June 1945 - Study of errors in Field Artillery Practice.

RECOMMENDATIONS:

a. That all fire-control instruments which are shown to produce errors in field artillery practice be replaced with improved instruments designed to eliminate the sources of error.

b. That in this replacement program, provisions be made for a maximum possible standardization of fire-control instruments for the various artillery pieces.

c. That full consideration be given to the evaluation of avoidable human errors arising in artillery procedures, as measured by their influence upon overall effectiveness of field artillery practices.

ACTION:

No known action.

Project No. 41 (Final Report) 8 November 1944 - Physiological and Operational Characteristics of Tank T25E1. Service Test of Medium Tank T25E1 by AMRL.

RECOMMENDATIONS:

I SEATS

a. Change height adjustment of bow seats and commander's seat to give four positions 29, 30, 31 and 32 inches below center of periscope window for buttoned-up operations.

b. Increase height, width and curvature of seat back for bow seats.

c. Paint seats with care so that adjusting mechanism and other moving parts will work satisfactorily.

d. Provide proper stowage facilities for gunner's seat back and for loader seat.

II HATCHWAYS

a. Provide improved locking and opening device for escape hatches to insure rapid use in emergency.

b. Provide more rapid action on locking device for bow hatches.

c. Eliminate interference with use of periscope and periscopic binoculars by commander's hatch lock.

d. Provide drain in splash deflector around bow hatches.

III CONTROLS

a. Re-locate accelerator pedal 1-1½" lower and change angle to give [illegible] to 10 toe-out position. Provide heel rest for left foot.

b. Re-locate turret lock for more convenient use by gunner.

c. Turn commander's turret control handle in along turret wall to remove interference with gunner's arm.

d. Eliminate interference now caused by piping with elevation hand wheel operation.

e. Provide thin padding under traverse gear housing to protect gunner's knee.

f. Improve engine door handles to reduce possible accident hazard in opening.

IV GENERAL VISION

a. Immediate consideration be given to the development of an improved vision cupola with less limited ground vision. In new design provide for hatch inside rotor as previously recommended, rather than with rotor in the hatch.

b. Provide rhombic vision units in turret wall for loader, in order to secure near ground vision.

c. Provide driver with wide field vision units (blocks or rhombs) possible supplemented by periscope for cross-tank vision.

V FIRE CONTROL

a. Provide for mounting and linkage for M10 Periscopic sight and to this end:

(1) Move lift eyes on gun shield
(2) Round corner of gun shield
(3) Lower armor around periscope
(4) Crown armor up behind periscope

b. Bulge turret side wall to give adequate lateral clearance.

c. Provide range finder in order to offset present limitation caused by obscuration from gun blast.

VI VENTILATION

a. Reduce noise level of 1000 cfm fan.

b. Relocate fan, if possible, to permit cross passage by bow crew members.

ACTION:

These tests and their results have been utilized in the development of new tanks.

Project No 44, 8 November 1944 - Physiological and Operational Characteristics of M-24 Tank. (Final Report)

RECOMMENDATIONS:

a. Eliminate provisions for winter heating of crew compartment which draws air from engine compartment.

b. Provide an independent system of positive-pressure ventilation for crew compartment of not less than 800 cfm.

c. Immediate consideration be given to the development of an improved vision cupola with less limited ground vision and installation of vision units

to provide close ground vision on the loader's side.

d. Immediate consideration be given to improvement of driver's vision.

e. Make provisions for accommodation of M10 periscope sight.

f. Improve telescope head rest adjustment.

g. Provide positive locking device for bow hatches when open.

h. Improve unlocking device on escape hatch to reduce effort required in operating.

i. Provide fasteners (positive) on seat cushions.

j. Improve seat back of mounting for easier removal.

k. Provide more clearance for operations of acceleratory pedal.

l. If possible, dish-in 75 mm gun recoil guard to provide leg room for commander.

m. Re-locate forward turret light fixture to central position shown in Figure 3.

ACTION:

These tests and their results have been utilized in the development of new tanks.

<u>Analysis of Physiological Characteristics of T9E1 Tank, 27 March 19[illegible].</u>

RECOMMENDATIONS:

I LIMITATION IN CREW SIZE

a. That crew members for the T9 tank be selected with regard to size according to the following measurements:

		Maximum	%Population Available
(1)	Standing height	69"	36
(2)	Erect sitting height	36"	36
(3)	Shoulder width	17½"	35

II SEATS

a. General.

(1) If the crew members are to be seated in the tank during landing, the seats must be designed to withstand, with occupants, the deceleration which takes place. Airplane type seats together with suitable tank, until after the airplane has landed conventional seats will be adequate, subject to the following recommendations.

b. Bow Seat.

(1) Provide driver's seat of bucket type, mounted in a fixed position 30" below the center line of the periscope window.

(2) Remove present back rest and provide removable back rest attached by telescoping joint to seat and capable of being raised 10-11 inches from seat.

(3) Locate driver's seat as far to right as possible and retain or increase, if possible, the present fore and aft adjustment.

(4) Relocate supporting brace which runs across floor and up side wall to provide more left shoulder room for driver and to permit lowering the seat.

(5) Move oil line guard to the right.

(6) Shorten steering levers and move forward 4".

(7) Move clutch pedal 3" to the left.

c. Turret seats.

(1) Provide turret seats with vertical adjustment in three 1" increments from 29" to 31" from the centerline of the periscope window.

(2) Consideration should be given to possible removal of turret floor to gain more leg room.

III VISION DEVICES

a. Driver's Vision.

(1) Provide three wide field vision units mounted in the hatch, as shown in Figure 4.

b. Gunner's periscopic sight, and vision unit.

(1) Replace present long periscope with standard periscopic sights, and arrange mounting to accommodate alternatively M4, T8 or M10 sights.

(2) Redesign turret roof to carry armor back from periscope level or even crowned up, as shown in Figure 5, to permit use of standard periscope and to gain head room.

(3) Provide vision unit in left side armor of turret, see Figure [illegible].

c. Commander's Vision.

(1) Modify commander's vision to provide for mounting periscopic

binoculars in a rotor of increased size together with one vision unit in armor on the right side of the turret, see Figure 6.

(2) Provide also for mounting of wide field periscope in place of periscopic binoculars.

IV HATCHWAYS

a. Driver's Hatch

(1) Redesign driver's hatch in accordance with suggestion in Figure 4. This will permit passage through it as well as improved vision.

(2) Eliminate present hatch raising mechanism and provide spring loaded hinges on new hatch with positive acting catch to hold it in open position.

b. Turret hatches

(1) Limit stowage over escape hatch to light-weight items which are easily removed for rapid access to hatch.

(2) If turret floor is removed, consideration should be given to relocation of escape hatch to permit use of the valuable space over present hatch for stowage of important items.

V GUN CONTROLS

a. Remove excessive play from turret traverse mechanism.
b. Provide larger elevating hand wheel.
c. Provide more substantial firing mechanism.

VI MISCELLANEOUS

a. Provide effective sealing around gun mount and other openings to minimize entry of liquid CWA.
b. Mounting of shell casing collecting bag.

(1) Relocate fastening pins on inside of recoil guard to eliminate needless interference.

(2) Provide ear tabs on bag to insure easier attachment and better fit.

c. Move turret light 6 inches to right.
d. Make possible checking of recoil oil without removing Cal. 30 MG.
e. Make storage battery more accessible, if possible.
f. Provide means for holding water drain valves in open position.
g. Arrange final drive oil drain for easier accessibility.
h. Reclocate headlights and guards as far forward as possible.
i. Redesign or relocate turret ammunition stowage so that ammunition can be removed when gun is fully elevated.
j. Install dust guards over tracks.

ACTION: These tests and results have been utilized in making of new tanks.

RECOMMENDATIONS:

I HATCHWAYS

a. Driver's and assistant driver's hatches.

(1) Provide stronger spring-loading for easier operation and carrying through from open to closed.

(2) Improve open locking mechanism for easier operation.

(3) Improve fit of inside lock and provide a positive seat for locking bar when rotated out of the way.

(4) When the new design is under consideration, the bow hatches should be arranged to give greater width of opening crosswise.

b. Escape hatches.

(1) Improve locking mechanism so that closing is positive but opening can be accomplished quickly without the aid of tools.

c. Commander's hatch.

(1) Redesign commander's hatch to permit the installation of adequate vision devices, preferably in the turret roof with the hatch located to the rear.

d. Loader's hatch.

(1) Enlarge area of passageway.

(2) Remount doors to open fore and aft and provide locking mechanism to hold them in open position 30° from horizontal.

II SEATS

a. Bow seats.

(1) Increase floor to roof height from 36-1/2" to 38-1/2".

(2) Provide two independent vertical seat adjustments, one consisting of a major shift of 10-1/2" from lower to upper position and the other, a series of four stops at 1" intervals to be operable at either level.

(3) Mount seats so that the height from the floor to the seat in the lower position is 1" when the fine adjustment is in its lowest stop.

(4) Provide fore and aft movement of the seats over a range of 4 inches with 1" increments (5 stops), the central position to lie at the present fixed position.

(5) Construct seat pads more firmly to prevent padding and install

positive fasteners for anchorage.

(6) Provide more durable upholstering materials for seat arms.

b. Commander's seats.

(1) Consideration should be given the replacement of the two seats, with a single seat having sufficient vertical adjustment to suit the commander in both "up" and "down" positions.

(2) Provide three 1" increments (4 stops) of adjustment in the down position with seat located from 29" to 32" from the center line of the periscope viewing window.

(3) Improve vertical adjusting mechanism to give smooth action and positive locking.

c. Loader's seat.

Improve shape of seat to give more uniform support.

d. Gunner's seat.

Provide vertical adjustment over a range of 36" to 44" from the roof to seat. The increments of adjustment to include four stops at 1" intervals from 36" to 39" to permit proper seat to eye adjustment for use of the periscope.

(2) Provide a simple insertion from which the back of the seat can be removed by a direct pull.

(3) Depress the seat back insertion below the cushion level to prevent injury to gunner.

III VENTILATION

a. Positive pressure.

Improve seals so that within the crew compartment a positive pressure of not less than 0.5", water gage, will be developed by the minimum rate of ventilation through the canister.

b. Rates of ventilation.

(1) The rate of ventilation through the gas canister should be the maximum which can be passed safely through the largest canister feasible of installation.

(2) Provide a rate of ventilation for general operation of the tank without canister of not less than 400 cfm with facilities for reducing the ventilation rate, as needed.

(3) Provide, for operation in extreme heat and humidity, a flow of not less than 1000 cfm, preferably as part of the positive pressure system. If this cannot be done, install a damper in the bulkhead which,

when open, will insure this rate of air flow through the crew compartment (engine idling, hatches open).

IV LIGHTS

a. Dual red and white lighting system.

Provide a dual system of lighting with white light for general use and red light for night operation. Retain present distribution of white light and install additional red lights as outlined in Project No. 7-2, 7-3, 25 Feb 43.

V VISION DEVICES AND SIGHTS

a. Commander's Vision.

Provide periscopic binocular spotter, rear vision mirror, and two flanking periscopes in a rotating mount in turret roof, independent of commander's hatch, or an arrangement which will give equal visibility and equal convenience of use.

b. Gunner's sights.

(1) Provide a periscope mounting to accommodate the T8 periscopic sight, with the necessary precision of mounting and linkage (12" lever arm) to insure an accuracy of movement within $\frac{1}{4}$ mil of parallism to bore of gun in all positions.

(2) Provide coaxial sight mount with smooth boresighting adjustment, independent in two directions and which links without disturbing alignment.

(3) Placement of sights in turret to be arranged so as to provide the following clearances:

(a) Horizontal distance of not more than 20" from plane of gun trunnion axis to eyepiece of coaxial telescope (with gun level).

(b) Lateral distance from eye position of telescope to nearest point of recoil guard, not less than 5". Recoil guard to be extended back parallel to the gun not less than 13" from eye position of telescope.

(c) Lateral distance from eye position of telescope to edge of periscope housing, linkage or other interferance, not less than 5".

(d) Vertical distance from eye position of telescope to turret roof, with gun at full depression, not less than 7 inches.

(e) With gun level, horizontal distance from axis of gun trunnion to the eye position of periscope to be 1-1/2" greater than the distance from trunnion axis to the eye position for the coaxial telescope.

(f) Vertical distance, from eye position at periscope turret roof, not less than 6-1/2".

(g) Turret roof slope ahead of the periscope, not less than 17°

(h) Controls for gun elevating and turret traverse to be placed with adequate clearance to insure access to coaxial telescope in all positions.

(i) Position of gunner's seat be fixed to insure knee clearance and adequate support when gunner sits far back to use telescope in elevation. These specifications are developed more fully in Projects 6-2, 6-4.

ACTION:

These tests have been utilized in the development of new tanks.

Project No. 45, 31 July 1945 - Operational and Physiological Characteristics of the Tank T26E3, (M26). Proposed Relation of 1000 cfm Blower.

RECOMMENDATIONS:

a. That if the 1000 cfm tank ventilating blower is relocated to the turret bulge position in future production M26 Tanks:

(1) A recirculating fan be located in the bow for additional air movement.

(2) An improved armored intake be designed and produced to give reduced resistance to air flow, either by the addition of turning vanes, improved air flow turns, or both.

(3) An improved discharge duct be designed to provide minimum resistance to airflow.

(4) Development be continued on a dust filter to reduce the dust concentration in the vehicle fighting compartment.

(5) Development be continued on a dust filter to reduce the dust concentration in the vehicle fighting compartment.

(6) Development be instigated to reduce the noise level of the axial flow blower.

(7) Adequate diversion of the auxiliary generator exhaust gases be accomplished to prevent entry into the fighting compartment.

ACTION:

Design changes were in progress to relocate the 1000 cfm fan from the forward hull position to the turret bulge for future production tanks at the close of hostilities.

9 Aug 1943 - Suggested Modifications in the Turret of the M5A1 Tank to Improve Gunner-Commander's Position, Use of Sights and Operation of Controls.

RECOMMENDATIONS:

That the proposed changes be referred to Tank-Automotive Center, Ordnance, for consideration and development, provided that the future production schedule for the M5A1 tank warrants this work.

ACTION:

These tests have been utilized in development of new tanks.

MISCELLANEOUS

These projects are not included definitely under the other main headings. A rough division has been made as follows:

1 - Pharmocology and Heat

2 - Dust

3 - Protective Devices Against Noise Injury

4 - Preselection

5 - Physical Fitness

6 - Fatigue

7 - True Miscellaneous

Project No. 18, 23 December 1943 - Investigation of the Effects of Activity and Environment on Atabrine Therapy.

RECOMMENDATIONS:

a. That the following studies be expedited:

(1) Field investigations in hyperendemic areas to determine the minimum plasma atabrine level required for the suppression of malaria.

(2) Further investigation, in the individual, of the value of the plasma atabrine level and other indices, as measures of antimalarial protection.

(3) Laboratory studies to improve the chemical method and equipment.

(4) A controlled field study of the toxicity of atabrine.

b. The minimum suppressive plasma atabrine level has not yet been established. Breakthroughs have occurred with weekly dosage of 0.4 gm. In the present study no toxic reactions occurred with this or larger suppressive doses. Pending results of the suggested studies, therefore, it is recommended that the dosage regimen for troops entering hyperendemic theaters be established as follows:

(1) 0.1 gm. atabrine twice daily after meals for 1 week, to be given not later than the week immediately preceding exposure.

(2) 0.1 gm. atabrine daily thereafter so long as exposed.

ACTION:

The findings and recommendations of this report have been incorporated into several medical department circulars. Circular letter, Office of Surgeon General 153, 19 August 1943.

Project No. 50, 26 April 1945 - The Physiological Effects of Ingestion of Large Quantities of Bursoline Treated Water.

RECOMMENDATIONS:

That the results of these tests be distributed to agencies responsible for Army water purification procedures.

ACTION:

On the basis of these and other studies, CMR of OSRD recommended that a large scale trial of Bursoline be held for the benefit of all services. It was suggested that this trial be carried out in the Marine Corps.

Project No. T-3, 3 January 1945 - Test of Expendable Dust Respirator, E5.

RECOMMENDATIONS:

a. That the E5 expendable respirator with minor modification of harness to eliminate discomfort of hooking device be considered adequate for use by troops insofar as its dust-protective quality is concerned.

b. Recognizing that the acceptability of any dust respirator by troops is primarily dependent upon its relative comfort in relation to severity of dust exposure, that the following action be taken:

(1) If military operations are anticipated in areas where extreme dust conditions may be encountered, the necessary supply of subject respirator be procured and issued to troops on an expendable basis.

(2) If operations in such areas is not anticipated in the near future that a limited supply of the respirators be procured for test of acceptability by troops operating in a military training area of known high dustiness.

ACTION:

No further development or procurement of a respirator of this type was known by this Laboratory.

Project No. 4-1, 10 September 1945 - Determination of Dust-Loads and Characteristics of Dusts Encountered in Operation of Armored Vehicles.

RECOMMENDATIONS:

a. Every effort should be made to reduce the amount of dust generated by armored vehicles and development of a practical air cleaner for use with positive-pressure ventilation of the tank crew compartment should continue.

b. Dust protective goggles and expendable respirators should be provided for armored personnel when needed.

ACTION:

Recommendations set forth are under consideration for post war development on future armored vehicles.

Project No. 5-8, 20 January 1943 - Estimation of the Practical Significance of Tank Noise.

RECOMMENDATIONS:

None.

ACTION:

No Action.

Project No. 5, 20 January 1943 - Effect of Exposure to Tank Noise Upon Hearing Acuity of Tank Crews.

RECOMMENDATIONS:

No recommendations made.

ACTION:

No action.

Project No. 12, 5 November 1943 - Test of Acousti-Guard (Ear Protective Device).

RECOMMENDATIONS:

Although the principle of the diaphragm valve-like action appears sound, the "Acousti-guard" in its present form fails to demonstrate this quality and therefore has no application.

ACTION:

No further development or investigation of this ear protective device was conducted.

Project No. 26, 5 August 1944 - Investigation of Ear Plugs for Protection Against Gun Blast.

RECOMMENDATIONS:

a. That acoustic protective device be provided for gun crews, gunner instructors and others regularly exposed to gun fire from large guns or to gun blast.

b. Basis of issue to be one pair of plugs per man exposed.

ACTION:

The NDRC V51 (Ear Warden) was procured for general issue by the Army for those requiring protection.

Project No. 8, 20 January 1943 - Preselection Tests. (First Partial).

RECOMMENDATIONS:

a. That no new man over 34 years of age be accepted by subsequently activated combat divisions. This limit may be changed by other considerations at a later date, but setting it at this limit now will eliminate a very considerable amount of wasted time in divisions being activated in the near future.

b. That all available information on the causes of reclassification and CDD's from other Armored divisions as they are activated be made available to the Armored Force Medical Research Laboratory for analysis.

ACTION:

No action.

Project No. 8, 22 April 1944 - Preselection Tests. (Second Partial).

RECOMMENDATIONS:

a. That the machinery for classifying men by physical qualifications be made available to all new units.

b. That the results of such classification be given maximal consideration in duty assignments.

ACTION:

No action.

Project No. 8, 17 March 1945 - Preselection Tests. (Final Report).

RECOMMENDATIONS:

a. That only those men who have the physical and mental qualifications of tank crewmen, as outlined above, be accepted for training as tank crewmen.

b. That consideration be given to reclassification of men after the sixth week of training at which time the reprofile status as well as performance evaluations by company commanders become available to provide additional bases for eliminating those likely to do poorly in tank driving and gunnery.

ACTION:

No action but favorably commended by Armored Center.

Project No. 5-32, 5 May 1943 - Driver Fatigue in Bendix Power Control Tank No. 908 as Compared with Standard M4A2 Medium Tank. (Final Report).

RECOMMENDATION:

From the point of view of driver fatigue, the installation of the Bendix Power Control in M4 medium tanks be considered as a desirable improvement. (Considerations of maneuverability, mechanical design and production and maintenance of the equipment are not within the scope of this report and will be reported upon by the Armored Force Board).

ACTION:

Armored Board failed to approve because of mechanical troubles.

Project No. 5-29, 10 March 1944 - Development of Tests to Evaluate the Physical Fitness of Men. (First Partial).

a. That this report be made available to all officers upon whom falls the responsibility of the physical fitness of the soldier.

b. That physical fitness tests be considered as aids in improving and determining the fitness of men; that they not be considered as final determinants of physical fitness.

ACTION:

Used as basis of tests in ration trials.

Project No. 5-13, 24 March 1945 - Appraisal of Kind and Degree of Physical Effort Required of Tank Crews in Relation to Fatigue.

RECOMMENDATIONS:

a. Agencies and individuals concerned in tank design should consider crew function and crew work rates in original design and continue efforts to render work within tanks more efficient and easy.

b. Agencies and individuals concerned in the design and testing clothing and equipment for tank crews should take cognizance of the work rates or endogenous heat production of the crew members.

ACTION:

No action.

Project No. 5-20 (sub-project) 9 May 1944 - Study of Schedules, Duration and Discipline of Rest Periods for Tank Crews on Long Marches.

RECOMMENDATIONS:

a. That the information in this report be made available to theater and training commanders.

b. That thorough training in long marches be included in the training of mechanized units.

c. That no long marches be undertaken without a through study of the feet and footgear of all personnel involved.

ACTION:

No action.

Project No. 45, 19 June 1945 - The Physiological Work Rates of the Driver and Loader in the Tank T26E3 in Relation to Fatigue and Efficiency of Performance.

RECOMMENDATIONS:

a. That measures be instituted in the T26E3, by restowage of rounds and/or by mechanical aids, to reduce loading work rates and to promote loading speed.

b. That the effect of stowage of rounds on the work rate, and the marked rise in work rate resulting from increased size and weight of rounds be carefully considered in future tank development.

ACTION:

No action.

Project No. P-51, 10 October 1945 - Manual Traversing Effort in Tanks.

RECOMMENDATIONS:

a. That data herein presented be considered in establishing requirements for manual traverse equipment for future tanks.

b. That effort be made to better balance turrets, reduce back lash in manual traverse equipment, provide more convenient faster method of shifting from power to manual traverse, improve power traverse for micro-adjustment and eliminate spade grip or reduce squeeze required to operate it.

c. That not over five pounds manual traverse effort under most severe conditions of tilt to be encountered be established for vehicles not equipped with power traverse.

d. That not over 10 pounds manual traverse effort for most severe tilt conditions to be encountered with maximum of 5 pounds on level be established for vehicles equipped with power traverse.

e. That production tests be set up to assure reasonable uniformity in manual traverse effort of like tanks.

ACTION:

No action.

Project No. 23, 3 June 1944 - Test of Non-skid Paint on Tanks.

RECOMMENDATIONS:

That non-skid paint not be considered for use on the exterior surfaces of tanks.

ACTION:

Recommendations followed.

Project No. 26, 6 May 1944 - Treatment of Mess Kits to Remove Glare.

RECOMMENDATIONS:

That the suggested process for treatment of aluminum mess kits for the elimination of glare be considered unsatisfactory.

ACTION:

Unknown.

Project No. T-9, 18 May 1945 - NDRC Infra-red Gas Analyzer for Determination of Rapidly Changing Carbon Monoxide Concentrations.

RECOMMENDATIONS:

No recommendations.

ACTION:

No action.

Project No. 32, 28 July 1944 - Letter Report on Test of Socks, Cushion Sole, Experimental.

RECOMMENDATIONS:

In view of the possibility that the socks may have been responsible for the skin reactions noted, it is suggested that a larger number of test socks be issued to infantry troops engaged in field activities and that observations be made by a medical officer at frequent intervals in order to determine the extent and severity of the reactions.

ACTION:

None.

PRESENT ALLOTMENT
OFFICERS

1 - Colonel
2 - Lt Colonels
5 - Majors
7 - Captains
4 - 1st Lieutenants (1 WAC)
2 - 2nd Lieutenants
21

TABLE OF ORGANIZATION

ARMORED MEDICAL RESEARCH LABORATORY

ENLISTED PERSONNEL
3 - Master Sergeants
2 - Technical Sergeants
13 - Technicians - Third Grade
9 - Technicians - Fourth Grade
12 - Technicians - Fifth Grade
4 - Privates - First Class
2 - Privates
45 - TOTAL

COMMANDING OFFICER
1-Col., MC 1-CAF-5

EXECUTIVE OFFICER
1-Lt Co., SnC

ADJUTANT
1-1st Lt., WAC 1-Tec 5(WAC)
1-2nd Lt., MAC
1-M Sgt 3-CAF-4
2-Tec 4 (1-WAC)

SUPPLY
1 M Sgt 1-Tec 3 2-Tec 4
1-CAF 4

LIBRARY
1-CAF-6
1-CAF-3

CLINICAL SECTION
1-Major, MC
1-CAF-5

SERVICES
1-Tec 4 2 CFC-3
2-Tec 5 1-Pvt

PHYSICS SECTION
1-Lt. Col., SnC
1-Capt., CWS 1-Tec 3

ENGINEERING SECTION
1-Major, SnC 1-T Sgt

HOT ROOM STUDIES
1-Major, MC
2-Tec 3 1-Tec 5
1-Tec 4 1-CAF 5

COLD ROOM STUDIES
1-Major, SnC
1-Capt., MC
2-Tec 3

CLINICAL INVESTIGATION
2-Capt., MC
1-Tec 3

CHEMISTRY
1-Major SnC 1-2nd Lt., SnC
1-M Sgt 1-Tec 4
1-T Sgt 1-P-3
1-Tec 3 1-SP-3

GEN'L ENG
1-Capt., MAC
1-Tec 3

VENT ENG.
1-Capt., FA
1-Tec 4
1-Cpl

UTILITY
1-P-4 In Charge
2-Tec 3

SHOP
1-SP-8 In Charge
2-Tec 3

FIELD TEST
1-Capt., Inf.
1-T Sgt
1-Tec 4
1-Tec 5
1-Pvt

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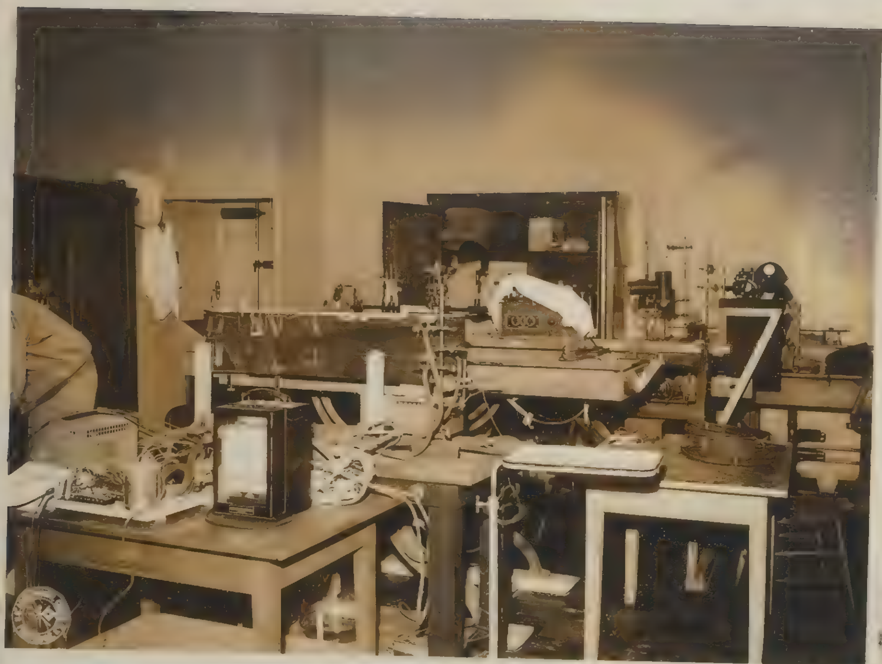

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